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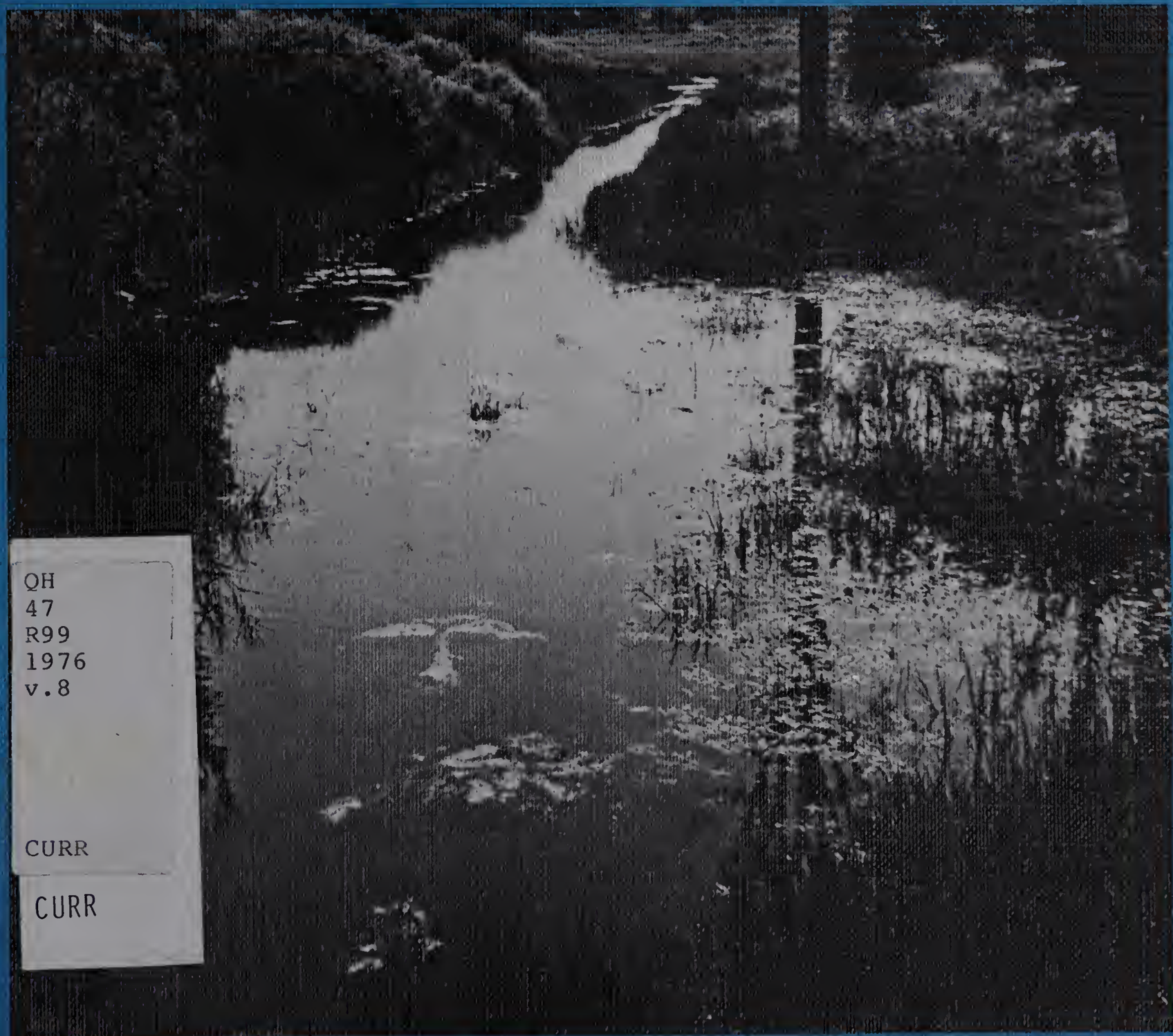
Studying Streams

In Action

METRIC EDITION

Allan Daynes



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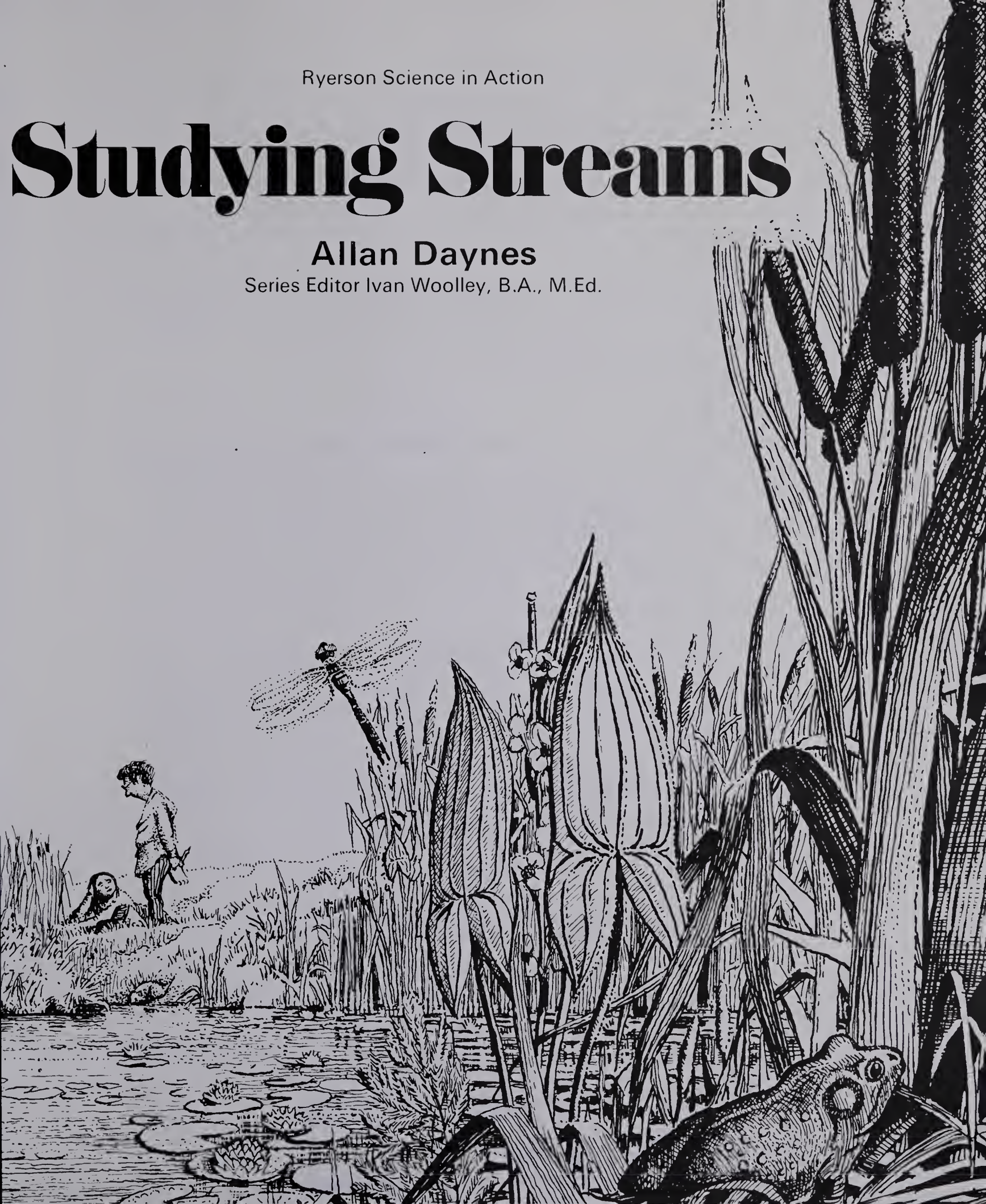
Studying Streams

Allan Daynes
Series Editor Ivan Woolley, B.A., M.Ed.



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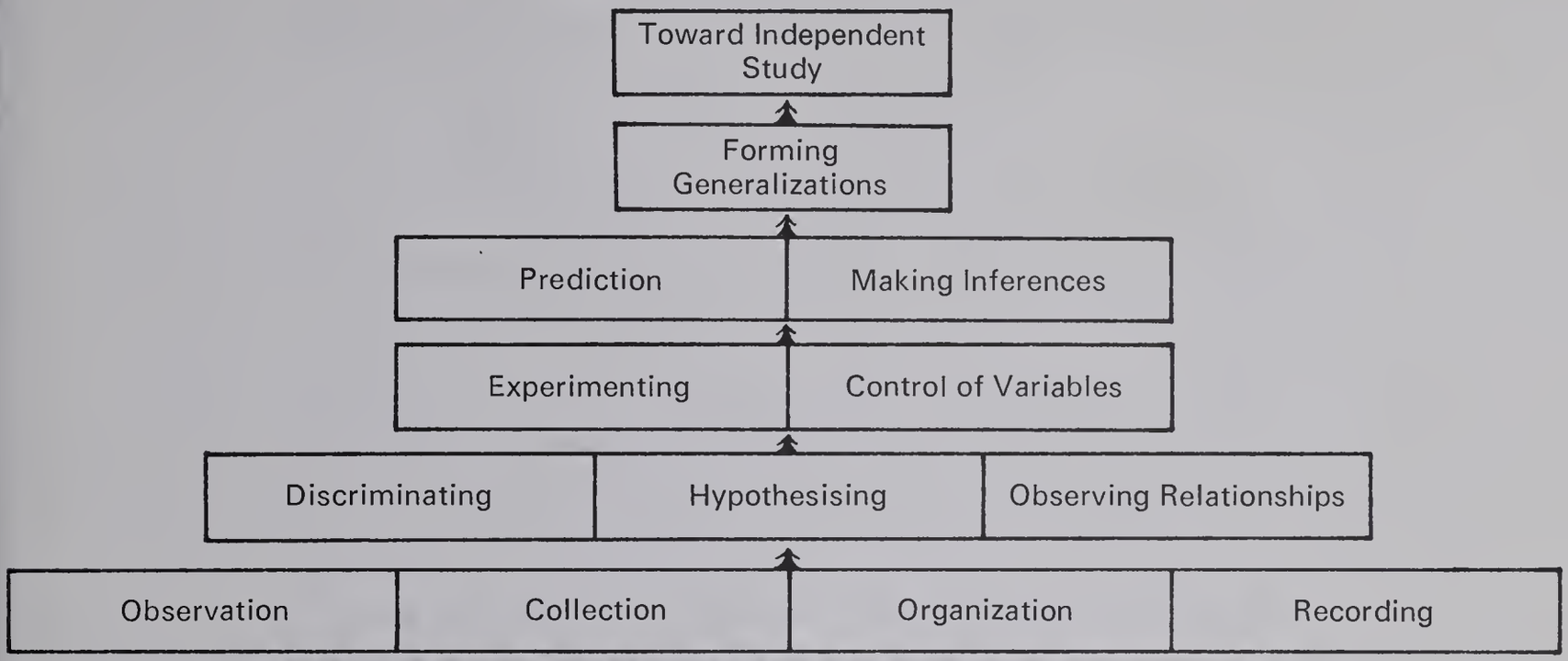
TO THE TEACHER

Water, out-of-doors, holds a natural fascination for us all. As children we are drawn to the small ponds and streams of our neighbourhood; as adults we seek out the lakes, rivers, and sea-coasts of our continent. An early appreciation of this valuable natural resource is necessary for its wise use and conservation. *Studying Streams* recognizes the strong affinity of children to water as an ideal learning situation.

For teachers not familiar with the stream habitat, it is suggested that the activities of Chapters 1, 2, and 3 be attempted first. In particular, the activities of Chapter 3 will provide pupils with easily measured data. This will build confidence and enthusiasm for the challenge of finding, collecting and naming organisms in future stream visits.

The naming of organisms is not a major concern in this book—and should not be a major aim of a stream visit. There are many excellent books, filmstrips, and filmloops available with descriptions of stream plants and animals. Some of these are listed on page 124. Teachers and pupils will become familiar with the names, incidentally, while using the resource material for specific activity assignments.

The activities in the book encourage enquiries which will develop a responsible attitude and valuable skills. A summary of these skills follows.



An interesting environment

Chapter 1

WHY SHOULD YOU STUDY STREAMS?

Why are people worried about water pollution?

Why should we care about our rivers, lakes, and streams?

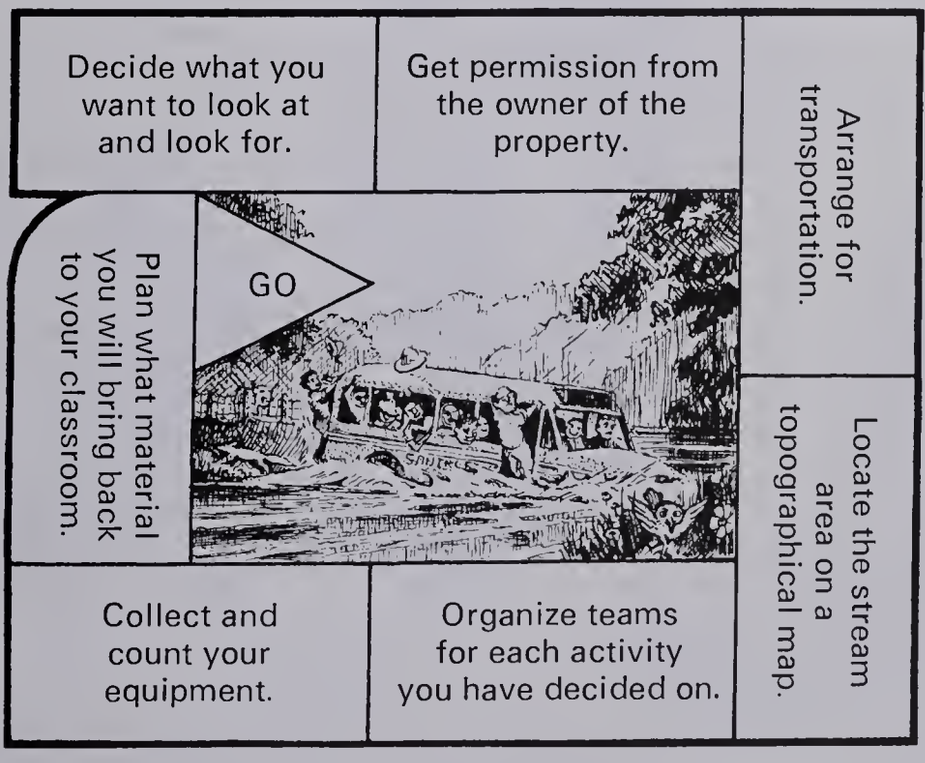
People are interested in investigating the stream community for a number of reasons. If a biologist knows some of the characteristics of unpolluted streams, he may quickly recognize when pollution is happening.

Other people, often called naturalists, enjoy the beauty and fascination of nature in a stream or pond. You will find, on your many trips to the stream, that what appears to be a very quiet scene is buzzing with tremendous activity. There are chases and escapes, attacks and retreats. Creatures are eating and being eaten. This is the struggle to survive!

In this book are many activities for you to try during your visit to the stream or afterwards in the classroom.

PLANNING, EQUIPMENT, AND PRECAUTIONS FOR STREAM VISITS

How should you organize your visit?


Decide what you want to look at and look for.
Get permission from the owner of the property.
Arrange for transportation.
Plan what material you will bring back to your classroom.
GO
Locate the stream area on a topographical map.
Collect and count your equipment.
Organize teams for each activity you have decided on.

What will you need for most stream visits? Actual equipment is listed under the heading "Materials" in each activity. However, articles you will probably want to take on all your field trips are:

Hat and sunglasses help to protect against heat and glare on hot, bright days. Take warm clothes in winter.

Camera for photographing the general features of the landscape, unusual features, or classmates at work.

A first-aid kit should be taken on all field trips. Plan with your teacher what you will include in such a kit.

Insect repellant for use in summer.

Rubber-soled canvas shoes for walking over rocks on the bottoms of streams. Rubber boots are necessary in winter but they are more awkward than tight-fitting shoes.

What general precautions should be taken on a stream field trip?

Suggested in the following scenes are several situations which may cause difficulty. How may these and other possible difficulties be lessened or avoided?

A stream in which the water is flowing rapidly and the bottom rocks are slippery.

A pond in which the water is hardly flowing and the bottom is deep mud.

Oversampling, that is, taking many more specimens from the stream than are required for classroom study.

Breakage of specimen bottles.

Chapter 2

RIVERS OF CANADA

O all the little rivers that run to Hudson's Bay,
They call me and call me to follow them away.

Missinaibi, Abitibi, Little Current—where they run
Dancing and sparkling, I see them in the sun.

I hear the brawling rapid, the thunder of the fall,
And when I think upon them I cannot stay at all.

At the far end of the carry, where the wilderness begins,
Set me down with my canoe-load—and forgiveness for my sins.

O all the mighty rivers beneath the Polar Star,
They call me and call me to follow them afar.

Peace and Athabasca and Coppermine and Slave,
And Yukon and Mackenzie—the highroads of the brave.

Saskatchewan, Assiniboine, the Bow and the Qu'Appelle,
And many a prairie river whose name is like a spell.

They rumor through the twilight at the edge of the unknown,
"There's a message waiting for you, and a kingdom all your own.

"The wilderness shall feed you, her gleam shall be your guide.
Come out from desolations, our path of hope is wide."

O all the headlong rivers that hurry to the West,
They call me and lure me with the joy of their unrest.

Columbia and Fraser and Bear and Kootenay,
I love their fearless reaches where winds untarnished play—

The rush of glacial water across the pebbly bar
To polished pools of azure where the hidden boulders are.

Just there with heaven smiling, any morning I would be,
Where all the silver rivers go racing to the sea.

O well-remembered rivers that sing of long ago,
A-journeying through summer or dreaming under snow.

Among their meadow islands through placid days they glide,
And where the peaceful orchards are diked against the tide.

Tobique and Madawaska and shining Gaspereaux,
St. Croix and Nashwaak and St. John whose haunts I used to know.

And all the pleasant rivers that seek the Fundy foam,
They call me and call me to follow them home.

Bliss Carman

FLOWING WATER HAS MANY NAMES

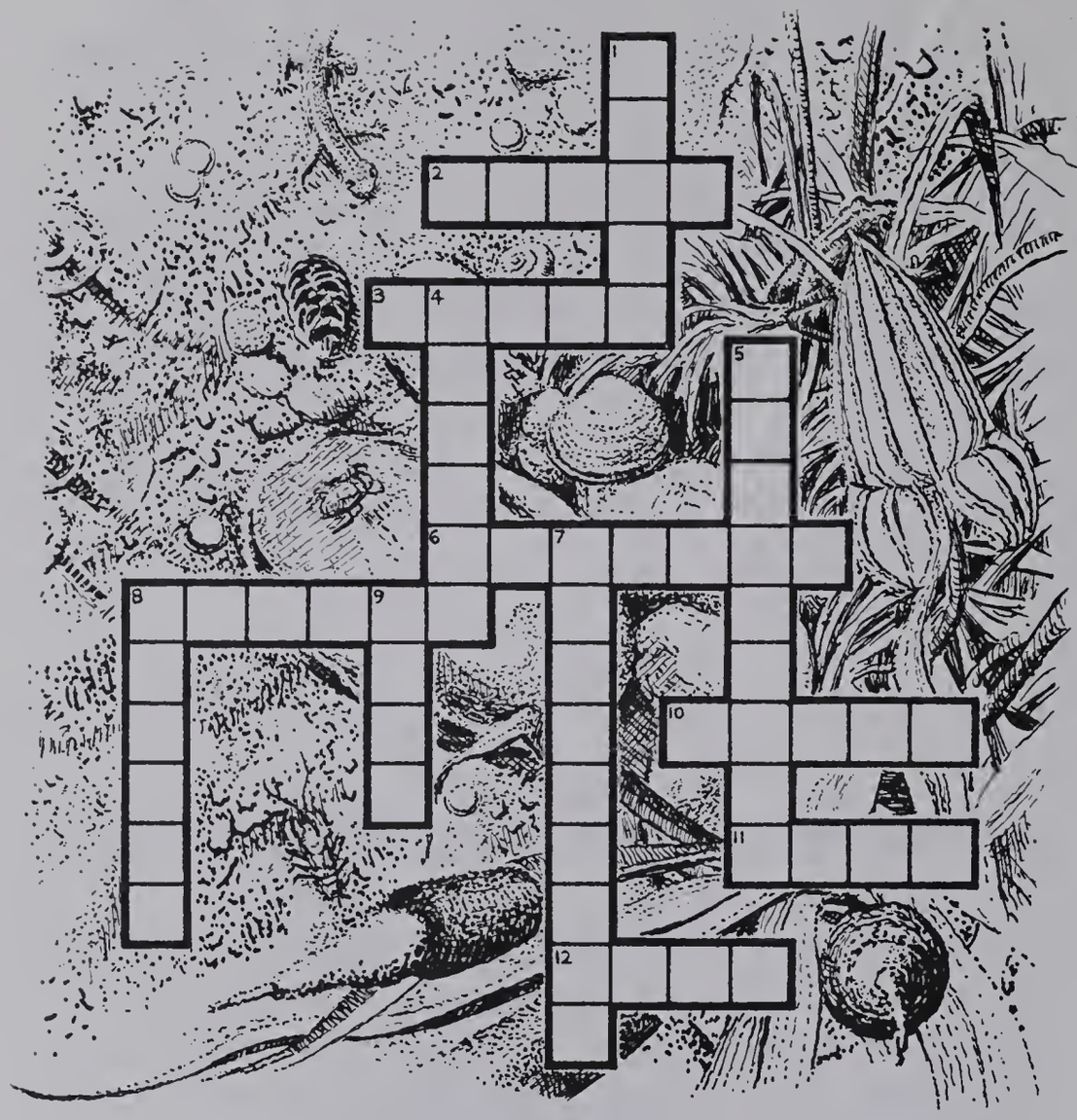
Can you sense in this poem the author's love for Canada and outdoor life? He uses many picturesque phrases to describe the beauties of a fast-flowing river or of a quiet pool.

As a young scientist, however, you may find yourself puzzled by a confusion of terms when you begin your study of water. For example, what is the difference between a creek, a rill, and a brook? When does a stream become a river? What is a tributary? Is there any difference between a large pond and a small lake?

By solving the puzzle on the following page you will find the differences in meaning of some of these terms.

Draw a diagram or word flow-chart to show water travelling from its source to its destination. Try to include as many of the terms used in the crossword puzzle as possible.

In very hilly or mountainous country you might expect to find more quickly flowing water with waterfalls, rapids, and fast-running streams and rivers. On the other hand, rivers and streams in very flat land usually are slow-moving. They are often marshy or swampy.



ACROSS

2. large, natural flow of water
3. rivulet; creek; small stream
6. troughs for drainage
8. marsh; bog; slough
10. soft, wet land
11. large area of water in a land basin
12. tiny stream

DOWN

1. a small stream
4. steep descent with strong current
5. water dropping from a height
7. small stream flowing into larger stream or body of water
8. a natural watercourse up to about 5 metres wide
9. small enclosed body of fresh water

TOPOGRAPHICAL MAPS

When planning a car trip you usually work out your route on a road map. You need to know how far away your destination is, how long it will take to get there, which are the best roads to travel, and so on.

In the same way, much information about the region in which your study stream is located can be obtained by examining a topographical map. Perhaps you will want to look at such a map before selecting a stream to visit. Topographical maps contain so much information that a great amount of skill and practice are required to read them. You need to know how to locate hills, valleys, streams, rivers, swamps and marshes.

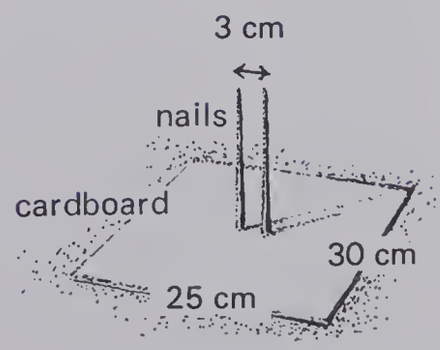
Activity 1
SHOWING A HILL ON A MAP

MATERIALS

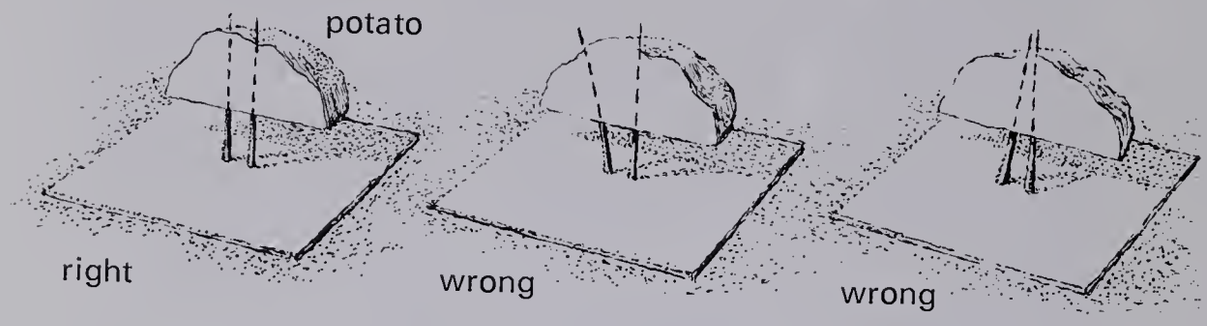
Very large potato
Sharp knife
Piece of stiff cardboard
Two long, thin nails
Marking pen

METHOD

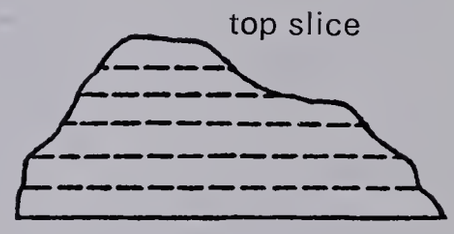
1. Cut the potato in half along its length. Half the potato will represent a hill.
2. Insert two nails through the cardboard about 3 cm apart.



3. Push the potato half down on the nails so that the cut surface rests on the cardboard. Be sure to keep the nails parallel as they pass through the potato.

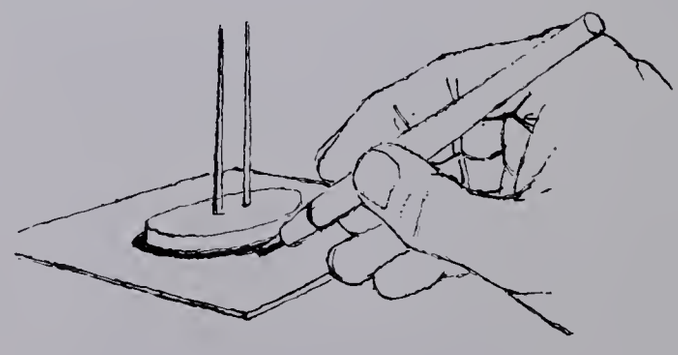


4. Remove the potato from the cardboard and nails. Cut five or six slices down the length of the potato. The slices must be the same thickness. This will take some practice!



5. Build the potato slices back on top of one another.

6. Take the top slice and insert it through the nails on to the cardboard. Trace its outline on the cardboard with a marking pen. Remove the top slice from the nails and repeat this step with the second slice. After the outlines of all slices have been traced, rebuild the potato.



Examine the shape of the potato and the traced lines, and answer the following questions.

1. Some of the traced lines are closer together than others. What features on the potato account for the lines being closer together or further apart?
2. What does the word "contour" mean? What are "contour lines"?

Use a reference book describing topographical maps and contour lines to answer the next three questions.

3. How is a stream that is flowing down a hill shown by the contour lines?
4. In which direction does the "V" showing a river valley point, upstream or downstream?
5. If, on a topographical map, a stream crosses several contour lines in a very short distance, what would this tell you about the speed of the water?

Activity 2
EXAMINING A SECTION OF A SIMPLIFIED TOPOGRAPHICAL MAP

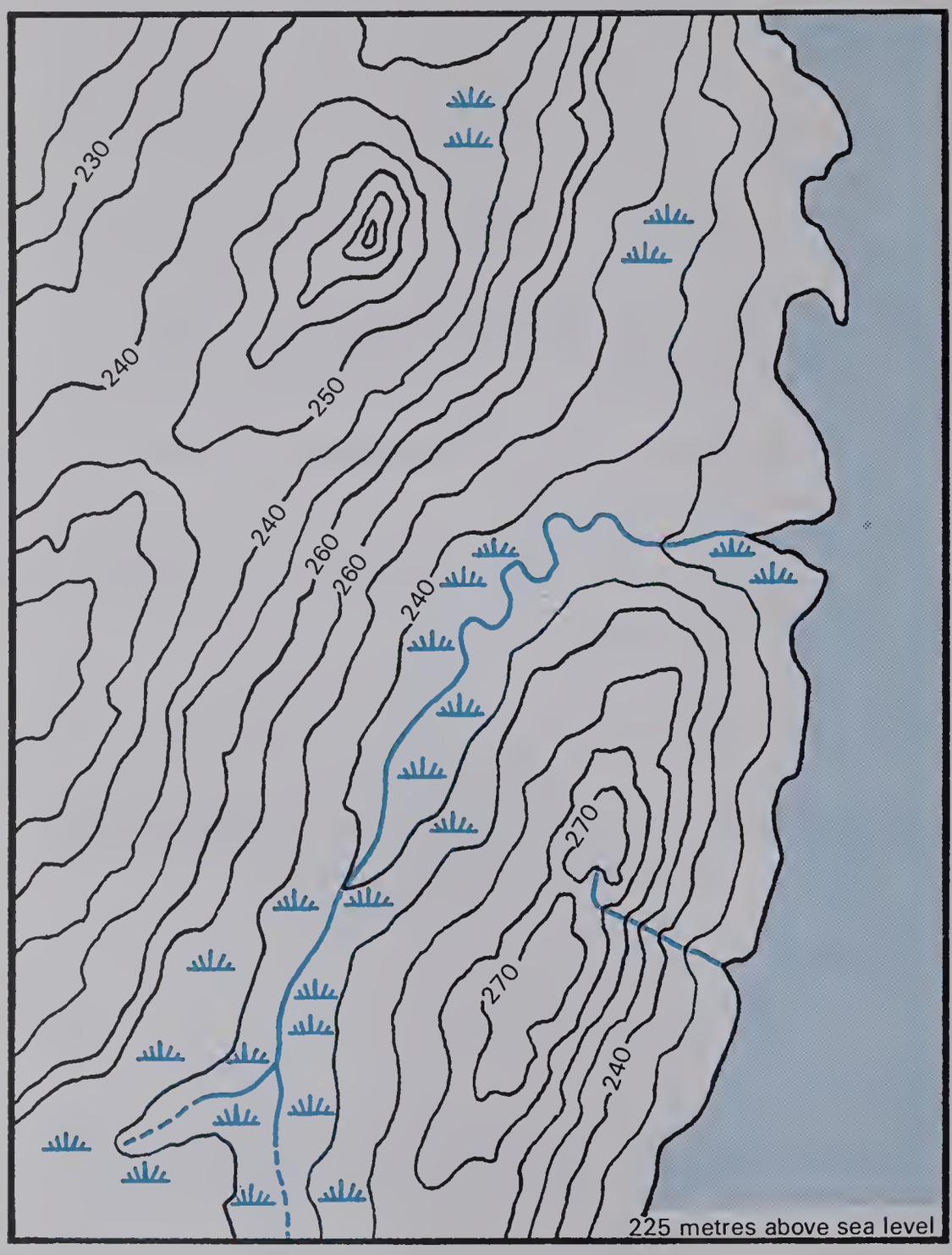
MATERIALS

A diagram of a topographical map.

METHOD

Examine the diagram of the topographical map and answer the questions.

1. Look at the Key to the map. How are swampy areas shown on the map? How many metres are there between each contour line?
2. How are hills shown on the map? Find the highest hill on the map. How high is it?



KEY

Contour interval: 10 m (elevation in metres above sea level)

Stream:

Intermittent stream:

Swamps or marshes:

Scale: 1 cm to 400 m

3. Find the longer stream shown on the map. At what height above sea level are its sources? At what elevation is the mouth? What is the difference in height between the sources and the mouth? This stream is about 20 km long. Do you think the stream is fast-flowing or slow-flowing? Why?
4. Find the shorter stream shown on the map. At what height above sea level is its source? At what height above sea level is its mouth? What is the difference in height between the source and mouth? How long is the short stream? Do you think it is a rapidly-flowing or slow-flowing stream? Why?
5. If topographical maps (see page 125) are available for the area in which you live, look at them carefully to discover the types of streams and rivers. Perhaps you could plan a field trip to a nearby stream.

Chapter 3

PHYSICAL CHARACTERISTICS OF STREAMS

Your classroom community has a vital, living character when you, your classmates, and your teacher are there. It also has a physical, non-living aspect which might be called the "physical characteristics" of the room. These characteristics include the dimensions of the room, the arrangement of the desks, the colour scheme of the walls and ceiling, the temperature of the room, and so on.

The stream community also has living and non-living parts.

THE STREAM COMMUNITY

Some Non-living (Physical) Characteristics	Some Living Characteristics
1. Width and depth of the stream.	1. Animals which live in or visit the stream.
2. Speed of the water (current).	2. Plants which live in the stream or on its banks.
3. Bottom conditions of the stream.	3. Bacteria in the water.
4. Minerals in the water.	
5. Amount of oxygen present in the water.	
6. Harmful chemicals (pollutants) in the water.	
7. Temperature of the water.	

Activities in this chapter will help you to understand some of the physical characteristics of the pond or stream you visit. You will find that one physical characteristic may be related to another. For example, the speed of the current and the type of bottom of a stream are related. The kinds of plants and animals found in particular locations are related to physical factors as well. You will see examples of this in some of the activities in Chapters 4 and 5.

TEMPERATURE ACTIVITIES

Activity 1
MEASURING WATER TEMPERATURE

MATERIALS

Thermometer with a temperature scale from —10° C to 110° C
Pad and pencil to record results

METHOD

1. It is very important that you read the temperature while the bulb of the thermometer is still under water. (Notice what happens when you do not read the temperature until you have pulled the thermometer out of the water.) Take each measurement twice to avoid errors. Readings should be to the nearest degree.
2. Take readings at several different places.
3. Record your results in the form of a chart as illustrated.

QUESTIONS TO THINK ABOUT

1. What effect does the location have on the water temperature?
2. How would the time of year affect the results? (See Activity 2.)
3. How would the time of day change your results? (See Activity 3.)

Name of stream: _____

Location of stream: _____

Date: _____

Temperature reading made by: _____

Place	Temperature (°C)
1. Near the shoreline. Water exposed to the sun.	
2. Near the shoreline. Water in the shade.	
3. In the centre of the stream. Water exposed to the sun.	
4. Section where water flows rapidly over rocks.	
5. Section where water is calm.	

Activity 2
MEASURING WATER TEMPERATURE OVER SEVERAL MONTHS

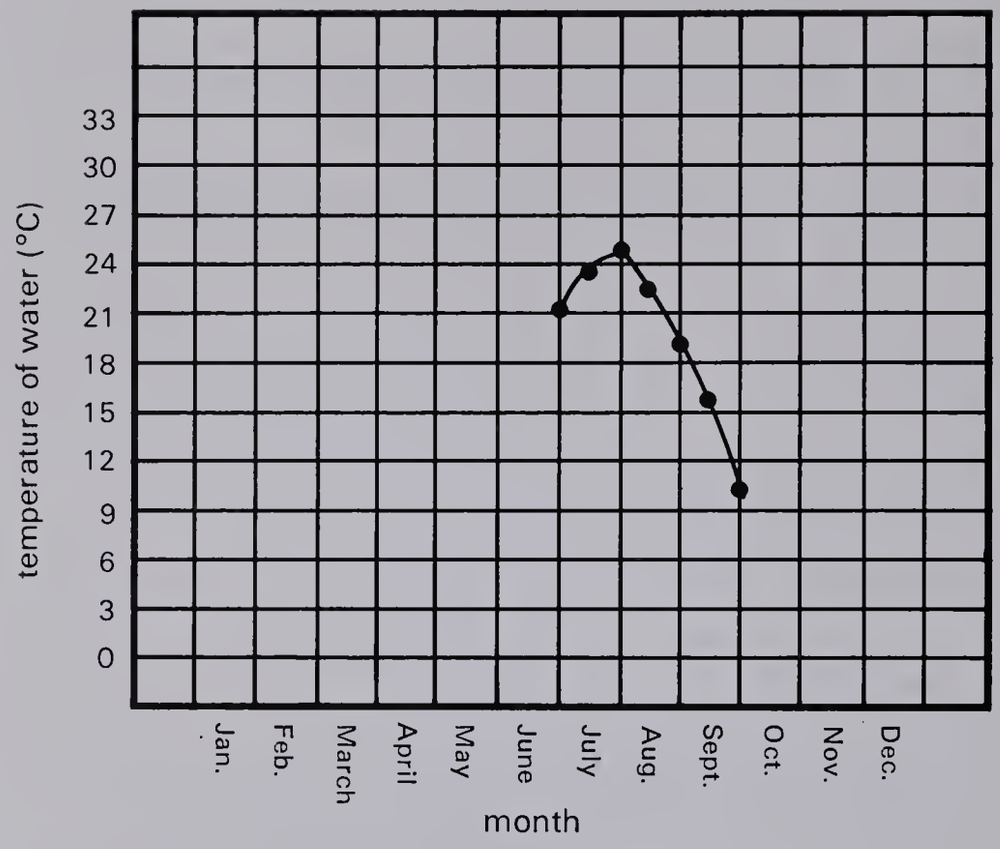
MATERIALS

These are the same as in Activity 1.

METHOD

Record the water temperature as described in Activity 1. Measurements should be taken once or twice a month. For each visit, also record the date, time, weather conditions and any obvious changes at the stream from the previous visit. Readings taken over a period of time may be expressed as a graph.

WATER TEMPERATURE
Name of Stream:
Location:



QUESTIONS TO CONSIDER

1. Would it make any difference if the water temperature for September 3 were measured at 12 00 and the water temperature for September 16 were measured at 17 00? If so, why? (See Activity 3.)
2. What is a "coldblooded animal"? Give an example of a coldblooded animal which lives in the stream. What effect will the lowering of the water temperature have on the temperature of such an animal?
3. How does a frog survive the winter?

Activity 3
COMPARING WATER AND SURROUNDING AIR TEMPERATURES

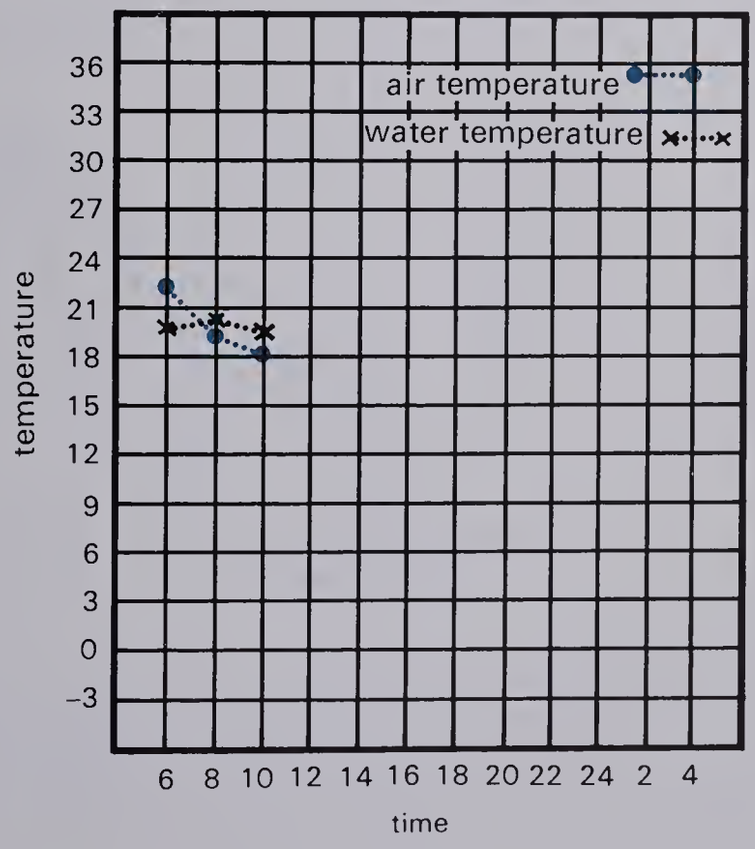
MATERIALS

Thermometer	Pencil
Note pad	Camping equipment

METHOD

1. Choose a stream not more than 30 cm deep and not rapidly flowing.
2. Measure the air temperature above the stream. It is best to take the reading in your own shadow so that the thermometer bulb does not receive direct sunlight. Why is this precaution necessary?
3. Measure the temperature of the water as described on page 24.
4. If possible, repeat the measurements every 1 or 2 hours over a 24-hour period. This will be fun if you enjoy camping. (Be sure to obtain permission to pitch a tent if the stream is either on private land or in a park.) It is important that two of you should work together, especially for the night measurements. Three teams of two could work 8-hour shifts. Record the name of the stream, its location, the date of the activity, weather conditions, and any unusual happening.

WATER AND AIR TEMPERATURES OVER A 24-HOUR PERIOD



Both the water temperature and air temperature may be plotted on the same graph if two different symbols and colours are used.

Name of stream: _____

Location of stream: _____

Date: _____

Weather: _____

Name of Person Measuring	Time	Air Temperature (°C)	Water Temperature (°C)
Team A			
1. Jim	18 00	21	20
2. Todd	20 00	19	20.5
3. Jim	22 00	18	20
4. Todd	24 00		
5. Jim	2 00		
Team B			
6. Peter	4 00		
7. Richard	6 00		
8. Peter			
9.			
10.			

THINK ABOUT THESE

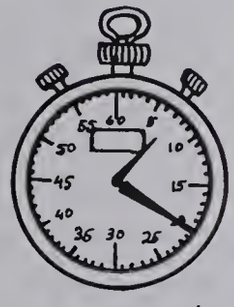
1. By how many degrees did the air temperature drop over the 24-hour period? During what hours did the greatest drop occur? Why?

2. How much did the water temperature drop over the 24-hour period? Why is there a difference between the drop in air temperature and the drop in water temperature?
3. Why, at each measurement, should the air temperature be taken before the water temperature?
4. On a very hot summer day the water feels quite cold when you first go in for a swim. But if you swim at night on the same day, the water feels warm. Study your results and explain this.
5. On very hot, sunny days, what advantage do stream dwellers have over animals living on exposed land such as rock cliffs and deserts?

SHAPE, BOTTOM, AND RATE OF FLOW

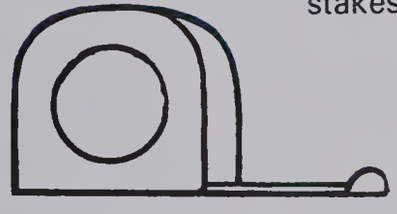
Activity 4
RELATING WATER SPEED TO STREAM BOTTOM

MATERIALS



stop watch

stakes


measuring tape

string

This activity is best carried out at two streams. Compare water speed and type of bottom in a rapidly-flowing stream with the same features in a slow-flowing stream.

METHOD

1. On pages 74 and 75 of *Studies for Open Places* there is a method for measuring the speed of water in a stream. Make several measurements over each distance. Here is an example of results obtained using this method.

Stream: *Jackson Park Creek*
Location: *Peterborough, Ontario*
Date: *May 3rd*
Weather: *sunny, clear, no wind*

Trial	Distance Travelled (m)	Distance from shoreline (m)	Depth of Water (m)	Time (s)	Rate (m/s)
1.	3	2	0.5	3	1
2.	3	2	0.5	3	1
3.	3	2	0.5	3	1
1.	6	2	0.5	6	1
2.	6	2	0.5	6	1
3.	6	2	0.5	6	1
1.	12	2	0.5	12	1
2.	12	2	0.5	12	1
3.	12	2	0.5	12	1

2. Describe the type of bottom in your stream by comparing the size of the rocks or stones or finer particles with familiar

objects. For example, the rocks may be larger than a football, or smaller than a football but larger than a softball, and so on. (You might also use a tennis ball, a golf ball, a marble, and sand.) The stream bottom may not be uniform from bank to bank. Compare, if possible, the speed of the water and the type of bottom (a) in the centre of a stream, and (b) about 0.5 metres from the shoreline. Then compare your results with those given.

QUESTIONS TO CONSIDER

1. How does the water speed in the example compare with your results?
2. What type of bottom was found in your stream?
3. After you have looked at the results of the example, can you tell whether the stream bed of Jackson Park Creek was muddy, sandy, gravel-like, or rocky? Give a reason for your choice.
4. What is the relationship between water speed and the type of bottom a stream has?
5. Why should three or more time-measurements or trials be made for each distance?
6. Why might the water speed in a stream or river be different at different times of the year?
7. If you chose a stream in which the water was moving very slowly, what might interfere with your measurements?
8. What difficulty would small water animals have in rapidly-flowing water?
9. What problem would aquatic plants have in quickly-moving water?
10. If you could design an animal to live on or under the rocks of a fast-flowing stream, what special features would you include?

Activity 5
PLOTTING THE SHAPE OF A STREAM OR RIVER BED

If a river is studied, it should not be more than 2 to 2.5 m deep and should not have a strong current. Only excellent swimmers in life-jackets should take the depth measurements, using a flat-bottomed boat.

MATERIALS

If you visit a shallow stream you will need:

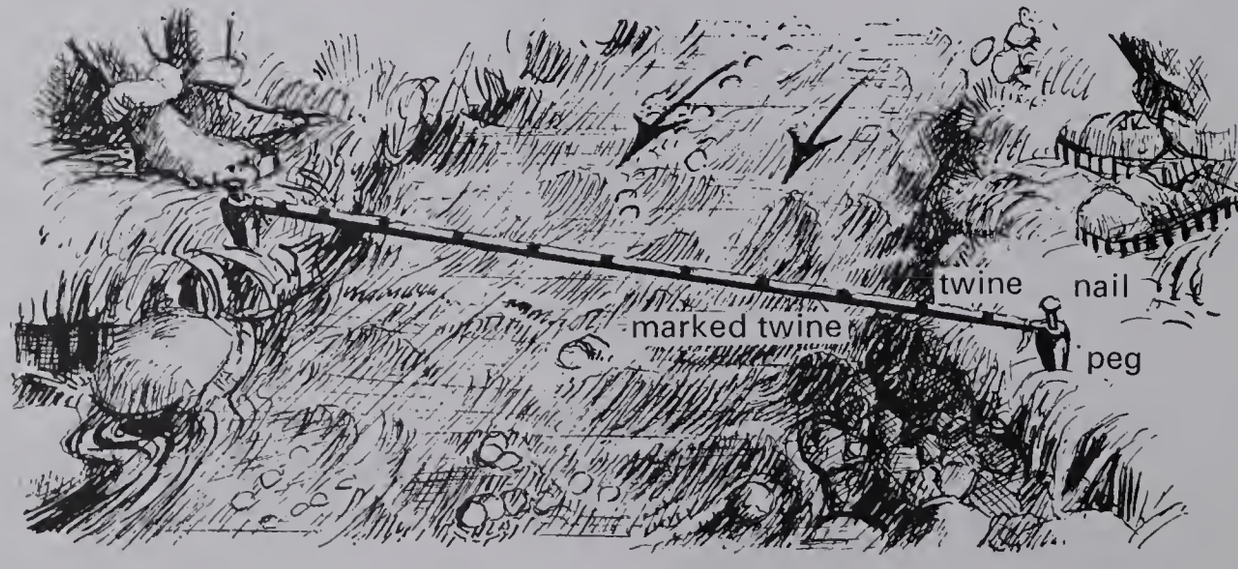
- metre stick
- ball of twine, marked off in metres
- two pegs, a hammer and nails

If you visit a river you will need:

- flat-bottomed boat
- nylon rope, marked every decimetre
- weight, to serve as anchor

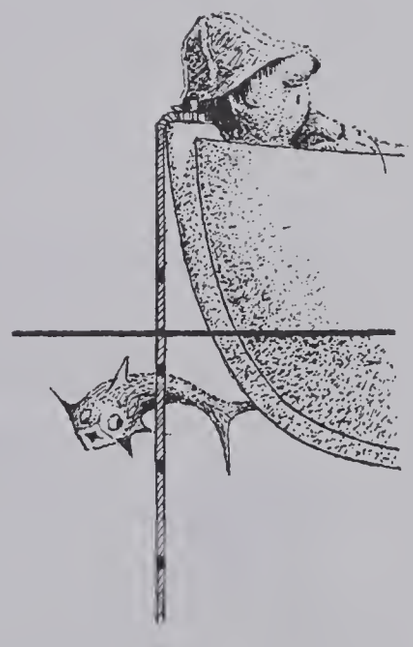
METHOD

1. For measuring a stream, set up the pegs and twine as shown.



2. Start at one shoreline and measure the depth of the water every 50 cm. (The interval may be larger or smaller depending on the size of the stream.) Turn the ruler so that the narrow edge faces upstream. You may want to shave the ruler edge to make it very narrow. What problem occurs when the broad edge of the ruler faces upstream?

3. If you test at a small river, several changes will be necessary. Measurements in deeper water will have to be taken from a boat. A heavy anchor will keep it from drifting downstream if the current is not too strong. Depth can be measured by lowering a weight tied to a nylon rope that has been marked every 10 cm. The anchor rope could be used both to keep the boat steady and to measure water depth. The number of measurements taken across the river will depend upon the size of the river.

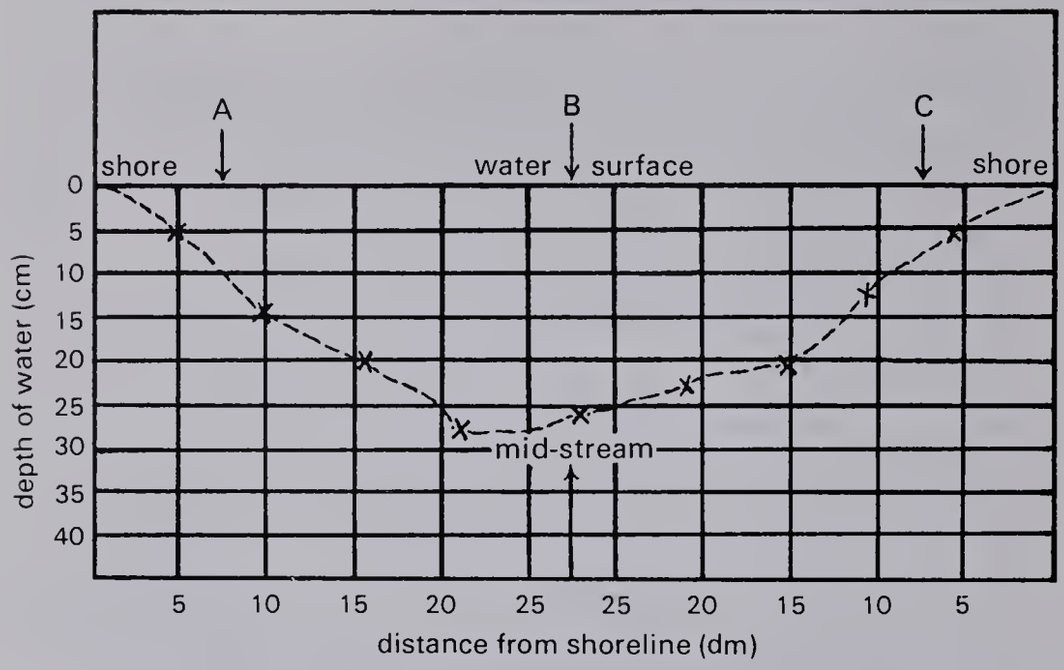


4. Record the name of the stream, its location, the date of the activity, the general weather conditions, and any unusual happening.

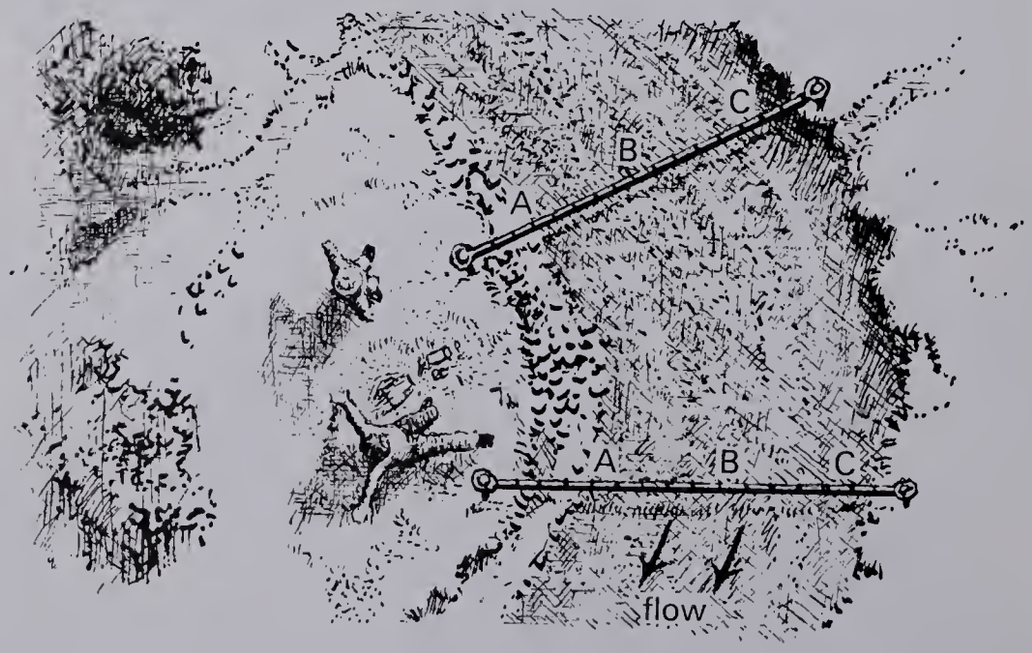
5. This activity may be combined with measuring the speed of the current. Compare the water speed at the shoreline, several metres from the shoreline, and at midstream.

Here are the results of a class trip to a stream, which shows one way that you might record your own results.

Stream:
Location:
Date:
Weather:



This picture of the stream bottom is a little distorted. This is because 40 cm on the vertical scale is about the same distance as 25 dm on the horizontal scale. Why are the scales different?



If you study a stream that meanders (twists and turns), carry out this activity and the water-speed activity at a bend in the river as well as along a straight stretch.

Compare:

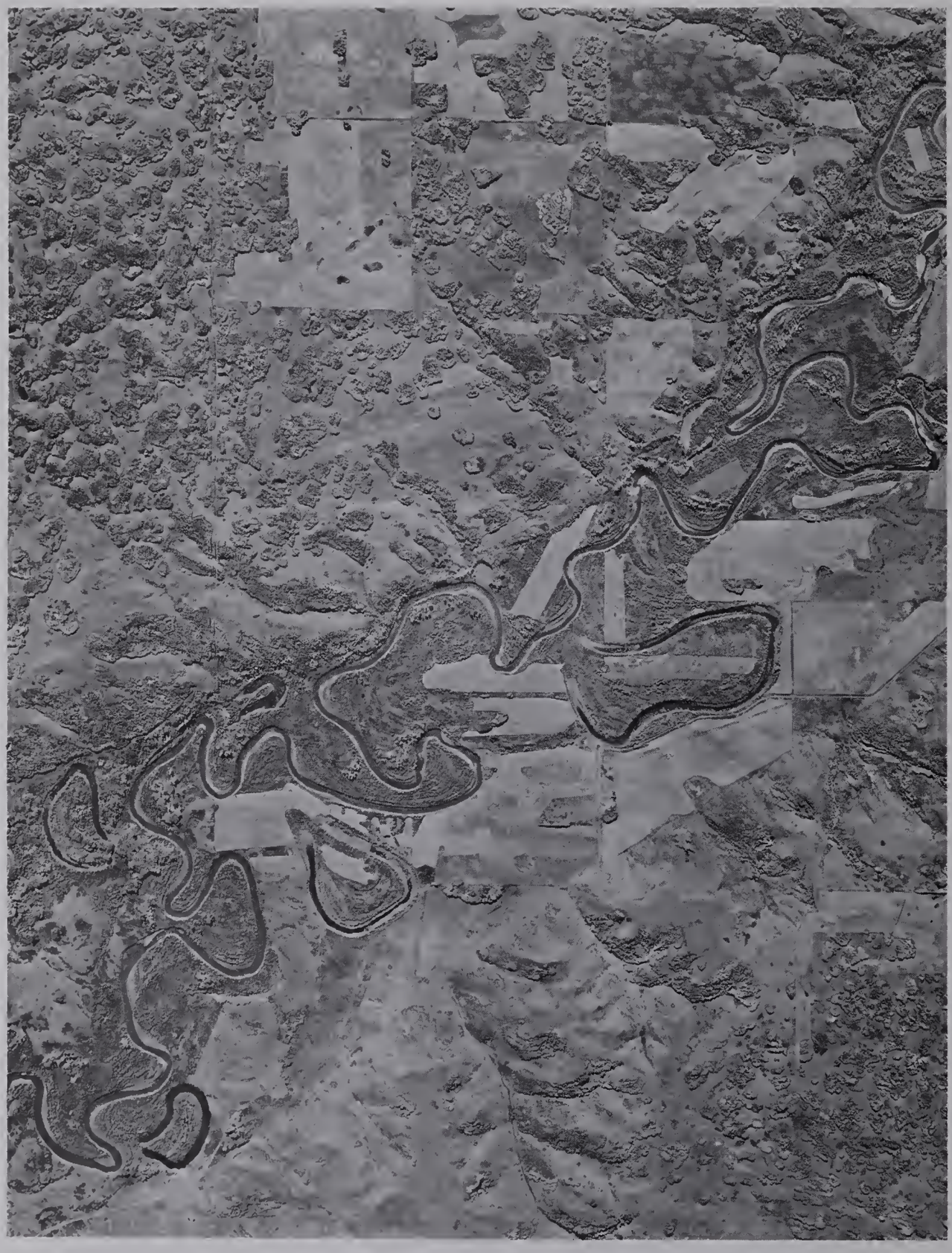
(a) the speed of the water at positions A, B, and C.
(b) the type of bottom at positions A, B, and C.
(c) the type of vegetation at positions A and C.

1. How are these three factors related to the shape of the stream bed?
2. What relationship might there be between the depth of the water and the speed of the current?
3. In the example of the meandering river, where do you suspect the speed of the current will be greater: at position A or C? Why?
4. Will the greater eroding effect of the water on the shoreline be near position A or C? Why?
5. Do you think a winding river will straighten out or wind to a greater degree after several years? Give reason for your answer.
6. Look at the aerial photograph. Find information about oxbow lakes in a reference book.

OXYGEN

All plants and animals need oxygen. The oxygen is used by living cells in a process which "burns" sugars to provide energy for the activities of the cells. But how can animals and plants which live in the water obtain oxygen, which is one of the gases that makes up air? (In Chapter 4, which discusses the animals in a stream, there are several ideas for discovering how certain animals obtain oxygen.)

Just as salt dissolves in water, so does oxygen from the air. Green plants in the water also add oxygen (as well as using small amounts) as a result of a process called *photosynthesis*. (See *Studying Plants*.) Photosynthesis is the building of sugar



An aerial view of Battle River, Alberta

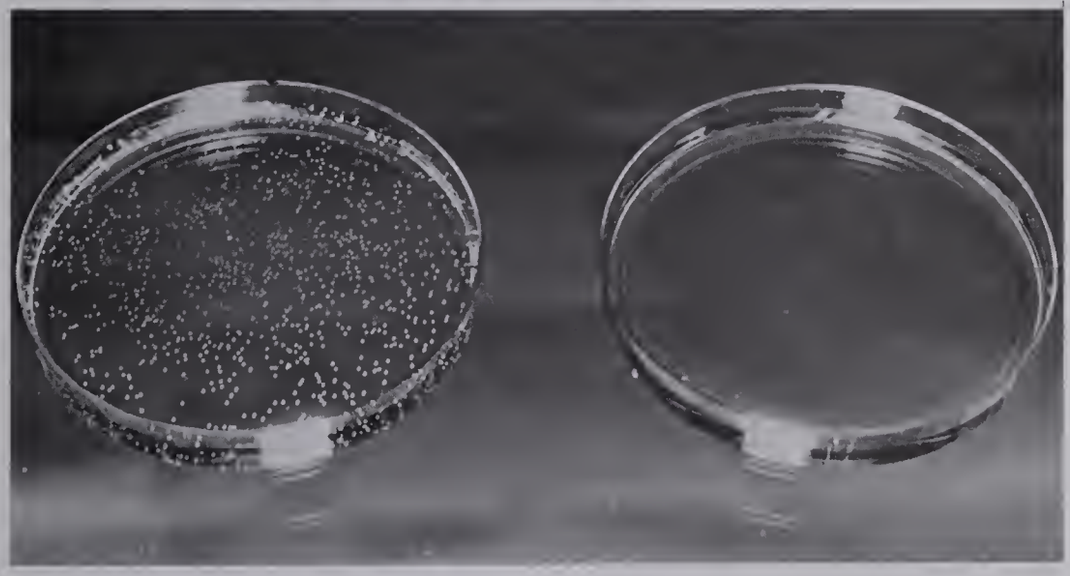
by green plants in the presence of sunlight, water, and a gas called carbon dioxide (CO_2). Oxygen gas is a by-product of the process.

$$\underset{CO_2}{\text{Carbon Dioxide}} + \underset{H_2O}{\text{Water}} \xrightarrow[\text{green plant cells}]{\text{sunlight}} \underset{C_6H_{12}O_6}{\text{Sugar}} + \underset{O_2}{\text{Oxygen}}$$

How can you measure the amount of oxygen dissolved in water? What units of measurement are used to express the amount?

The amount of oxygen dissolved in water is usually expressed as the number of parts of oxygen dissolved in every one million parts of water. This is a *concentration value*. For example, if a stream contains 10 parts per million (abbreviated to 10 ppm) oxygen, it means that for every one million parts of water examined, there are 10 parts of oxygen dissolved in it.

Take two glass or plastic culture dishes (a small glass tumbler will do) and add equal amounts of cold tap water to each. Place one of the dishes in the refrigerator and the other near heat—a radiator for instance. Examine both dishes after an hour or two.



A dish of cold water placed near a radiator (on left)
A dish of cold water placed in the refrigerator (on right)

You will notice that bubbles of gas collect on the side of the dish and under the water surface of the sample kept near the heat. This gas is water vapour with traces of other gases, including oxygen, which were dissolved in the water. In warmer water then there is less dissolved oxygen available for plants and animals. Temperature of stream or pond water will determine, in part, how much oxygen is dissolved in the water.

Try the following simple test. Boil some water in a kettle. While it is still hot, pour enough water into a pyrex baby bottle to completely fill the bottle, and seal it. Fill a second bottle one-quarter full of water and seal it. Allow the water in both bottles to come to room temperature.

A bottle filled with boiled water
A bottle half-filled with boiled water

Open the first bottle, which was completely filled, and taste the water. Shake the second bottle vigorously for half a minute, then open it and taste the water. What difference in taste do you

notice? What has shaking done to the water in the second bottle? What factor other than the water temperature may determine the concentration of dissolved oxygen in the water? What conditions along a stream or river would tend to *aerate* the water? How might the number of plants found in a pond affect the concentration of oxygen in the water?

How might a solid ice cover at a stream affect the concentration of oxygen in the water during the late winter months? Look up "winter fish kill" in your resource centre.

A number of polluting substances will lower the concentration of oxygen in stream or river water. More will be said about this problem in Chapter 6.

In many water filtration plants the taste of the water is improved by aerating it. Plan a visit to your local plant to discover how water is treated to make it safe to drink. (Chapter 6, Activity 6).

Activity 6
MEASURING OXYGEN DISSOLVED IN STREAMS

MATERIALS

A chemical kit for measuring oxygen concentration (See resource list at the back of this book.)

METHOD

Once you have learned how to use your kit, a number of tests can be carried out.

1. Measure the ppm concentration of oxygen in a stream over several months. This activity may be combined with the monthly temperature-measurement activity.
2. Measure the concentration of oxygen in the water over a 24-hour period. This may be combined with the 24-hour temperature measurement.

3. Compare the concentration of oxygen in water falling over rocks with that in water in a very calm part of the same stream.
4. Measure the concentration of oxygen in water located upstream and downstream from the sewage treatment plant in your area.

Remember to record the name and location of the stream, the dates of testing, weather conditions, and any unusual happening. Your results may be recorded in the form of a graph or chart, which might look like either of these.

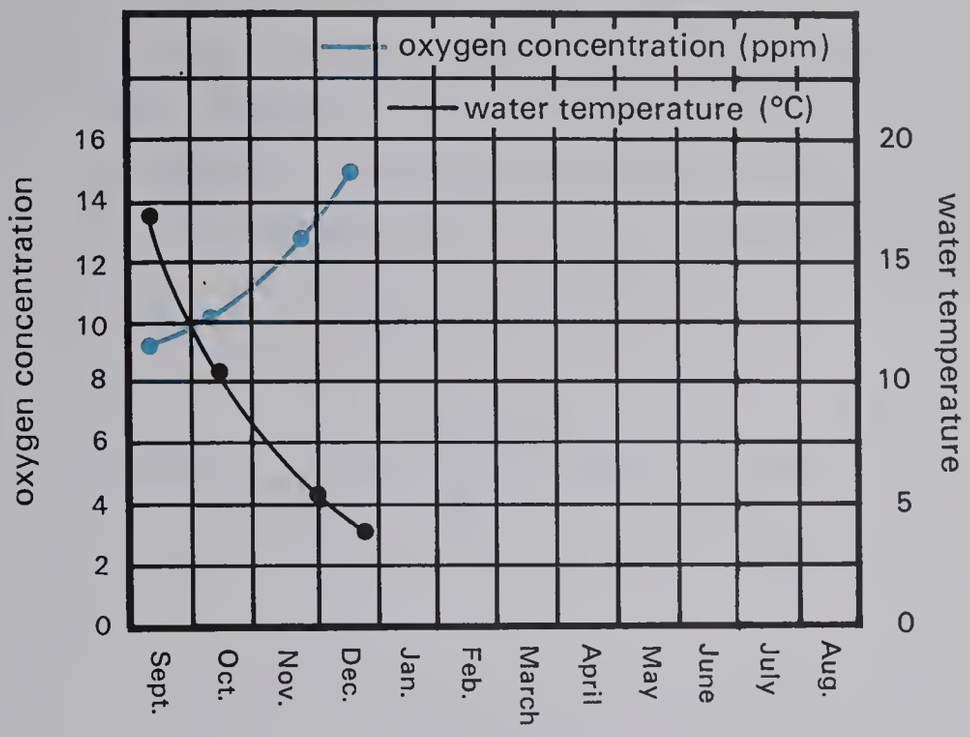
OXYGEN CONCENTRATION MEASUREMENTS

Name of stream: _____

Location of stream: _____

Date	Water Temperature (°C)	Air Temperature (°C)	Weather Conditions	Oxygen Concentration (ppm)
Sept. 10	17	20	sunny, windy	9.1
Oct. 20	10	7	sunny, no wind	10.0
Nov. 29	5	3	overcast	12.8
Dec. 21	3.5	2	sunny with clouds	14.8

OXYGEN CONCENTRATION AND WATER TEMPERATURE AT WHITE'S CREEK OVER ONE YEAR



You will notice that there is a left-hand vertical scale and a right-hand vertical scale. The graph shows both the monthly oxygen concentration values and the monthly water temperature values. Use different colours so that you can easily tell the two curved lines apart.

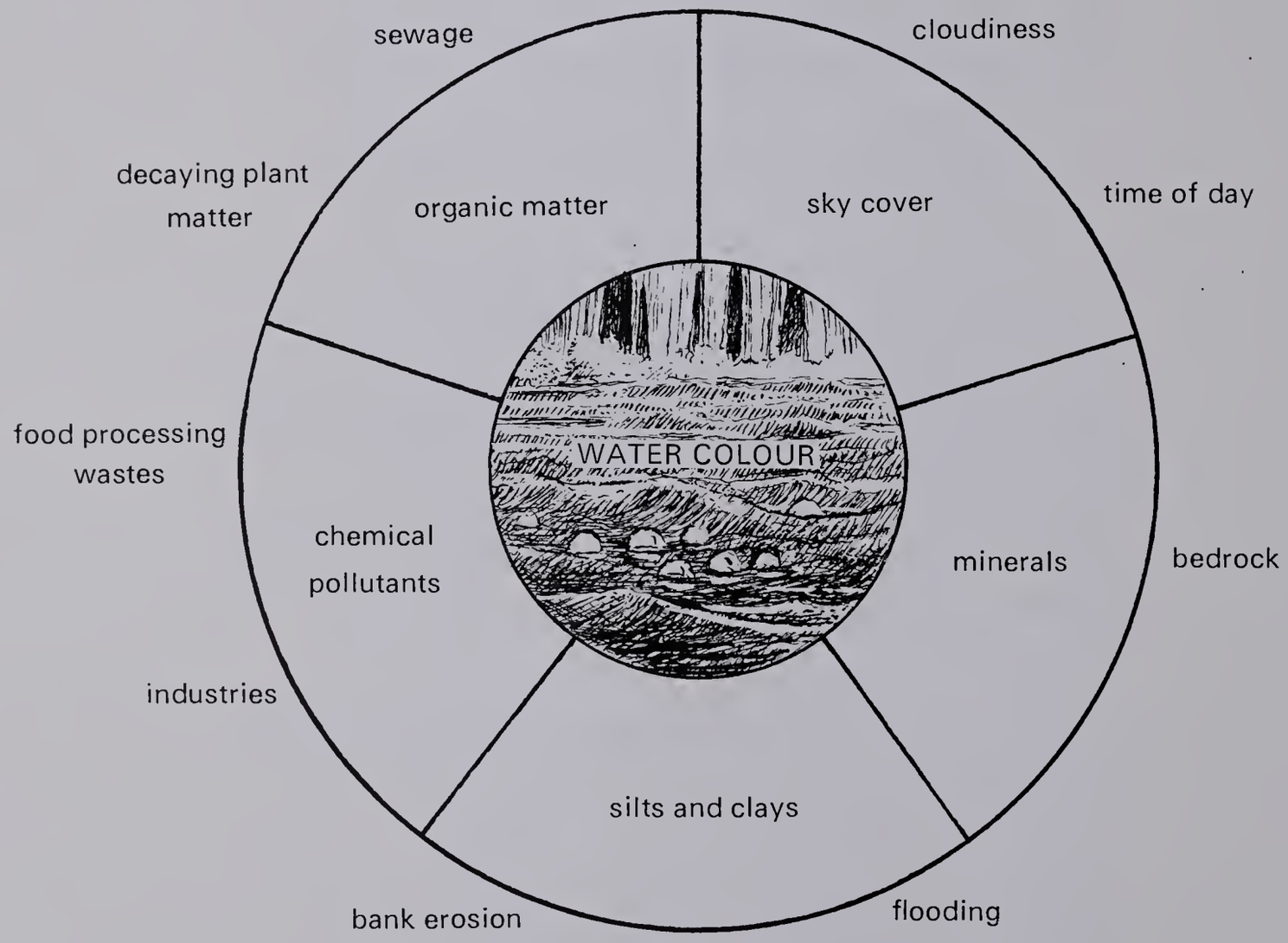
To discover whether or not the stream water contains the maximum amount of dissolved oxygen at a particular temperature, compare your results with the values given in the following table.

TEMPERATURE	MAXIMUM DISSOLVED OXYGEN IN PARTS PER MILLION
0°C	14.6
5°C	12.8
10°C	11.3
15°C	10.2
20°C	9.2
25°C	8.4
30°C	7.6

WATER COLOUR

Two characteristics of pure water are that it is clear and colourless. Why, then, does water often seem to be coloured?

Find magazine pictures and photographs that show the many colours of stream and river water. Try to discover what is causing the colour.



If you are studying a stream in an industrial area, a sketch of the stream indicating the location of various industries near it may be very useful in detecting the cause of the colour. (Not all chemical pollutants are coloured. Colourless pollutants are discovered by chemists who study the water in their laboratories.)

If you are studying a stream in a country area and the water appears to be brownish-grey, try to find areas along the stream where run-off may be adding soil to the water.

Chapter 4

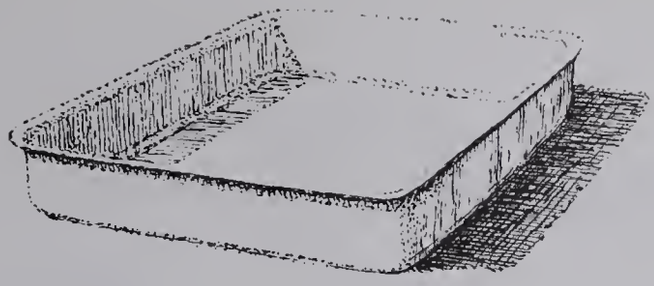
STREAM DWELLERS: WHERE AND HOW DO WE FIND THEM?

The picture shows several places where stream dwellers may be found. This does not mean that an animal cannot move from one area to another, or that you will find, at one stream, all of the places shown in the diagram. The speed and temperature of the water, the type of bottom, and the kinds of plant life will help to determine the animal life found there.

HOW DO WE CATCH THEM?

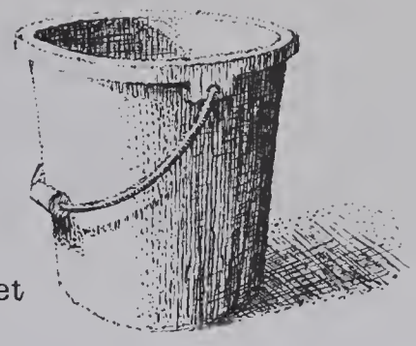
The method of sampling for or catching stream dwellers will depend mainly on two things—the size of the animal and where in the stream the animal is found.

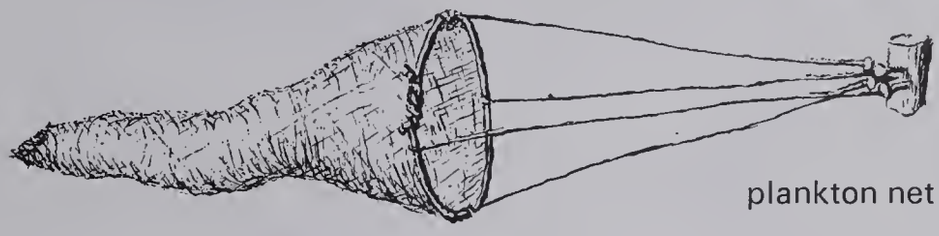
Here are some simple pieces of equipment that are used to catch stream dwellers.



white enamelled tray

plastic bucket

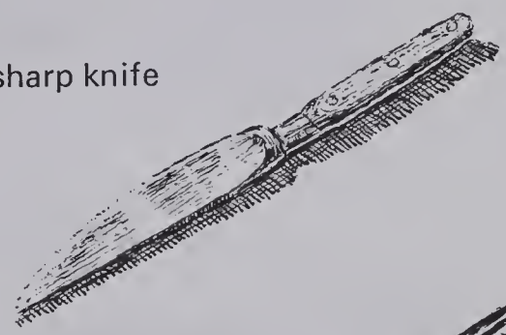


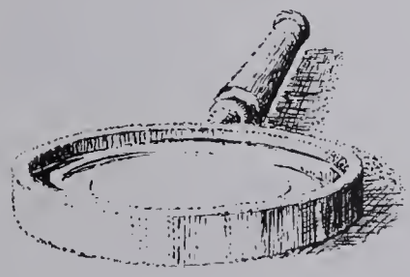


plankton net

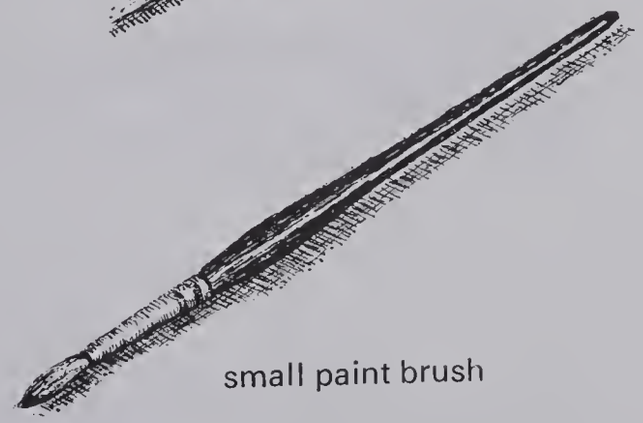
kitchen sieve

sharp knife

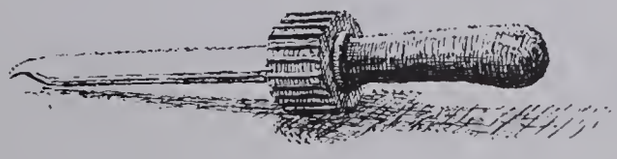




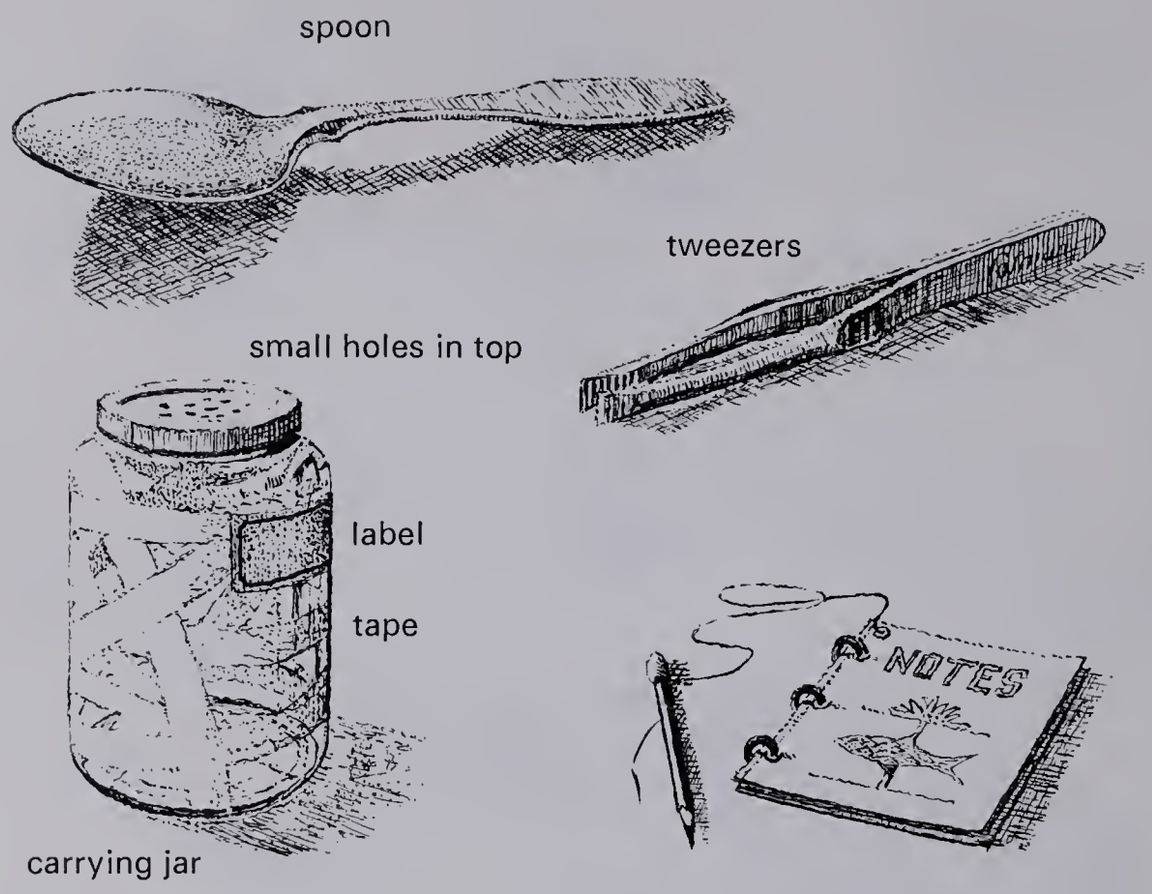
magnifying lens



small paint brush



eye dropper



pond dip net (a large kitchen sieve tied to a long handle)

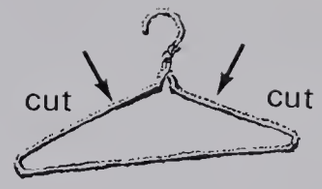
Activity 1
MAKING A PLANKTON NET

MATERIALS

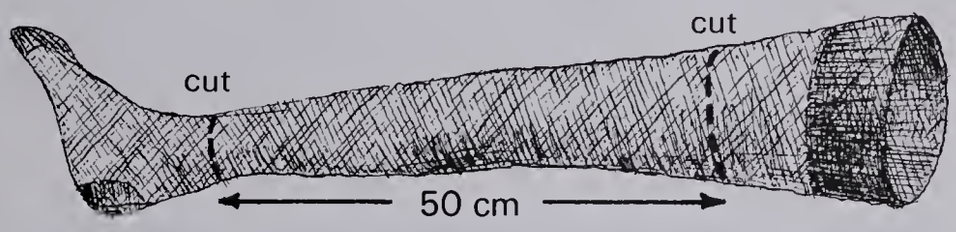
Coathanger
Picture-hanging wire or string
Nylon stocking
Needle and thread
Mending tape
Block of wood (5 cm x 5 cm x 2 cm)
Four screw-eyes

METHOD

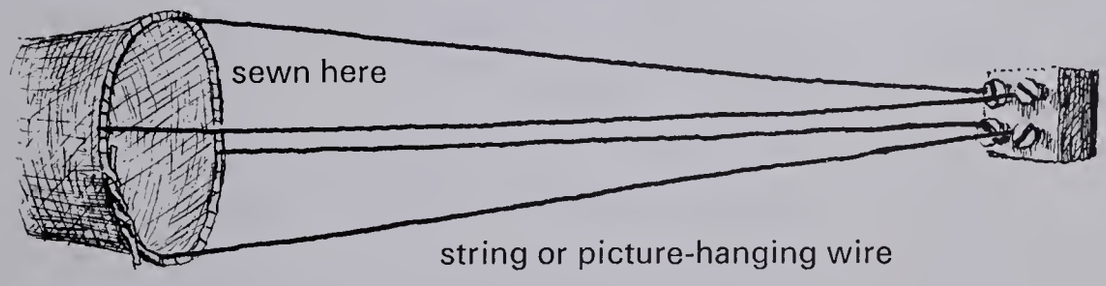
1. Cut the coathanger with pliers.



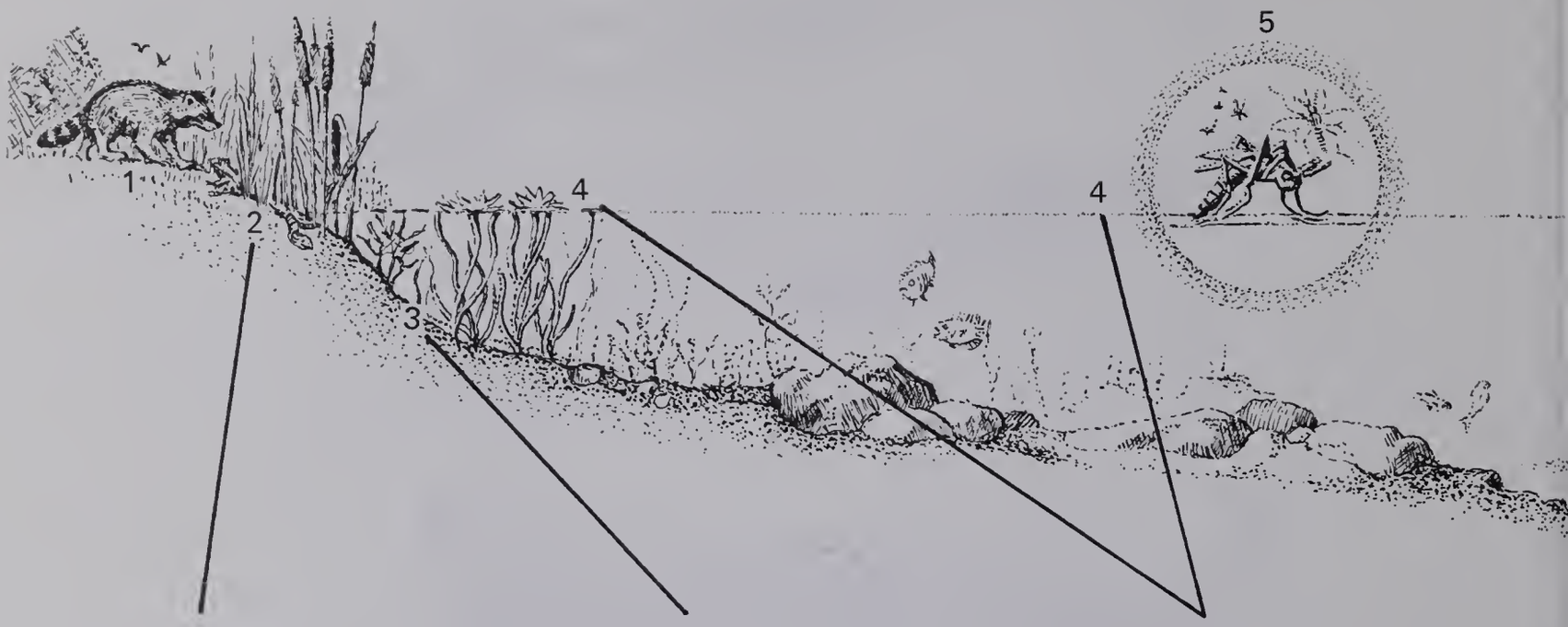
2. Bend the bottom half of the coathanger to form a circle with a diameter of about 15 cm.
3. Twist the two free ends of the wire around one another so that the wire loop will not pull apart. Wrap tape around the twisted ends.
4. Cut off the foot and top of a nylon stocking, leaving a length of about 50 cm.



5. Sew the larger end of the stocking to the wire loop.



6. Attach four pieces of string or picture-hanging wire to the loop and to four screw-eyes in a block of wood. The wood is a tow bar.
7. Fold up the narrow end of stocking about 5 mm and sew it closed with needle and thread.
8. Always wash the plankton net with water after use and hang it up to dry. Dry all metal parts to help prevent rusting.



Look for frogs, salamanders, snakes, birds and turtles here.

Except for birds and snakes, these animals may be caught by hand. Water snakes are not as "even-tempered" as garter snakes when disturbed, so it is better to leave them alone.

For transportation, these animals require large screened containers with a bed of wet moss and weeds. Do not fill the containers with water. Why?

Label the containers.

Drag the plankton net, kitchen sieve, or pond net through the weed bed. Cut some weeds with a sharp knife.

Transfer the cut weeds and catch into separate trays for a brief inspection.

Place the animals and the cut weeds together in carrying jars.

Label the carrying jars.

Date — October 7
Name of stream
Beaver Creek
Where found — on the surface in the weeds about a foot from shore.

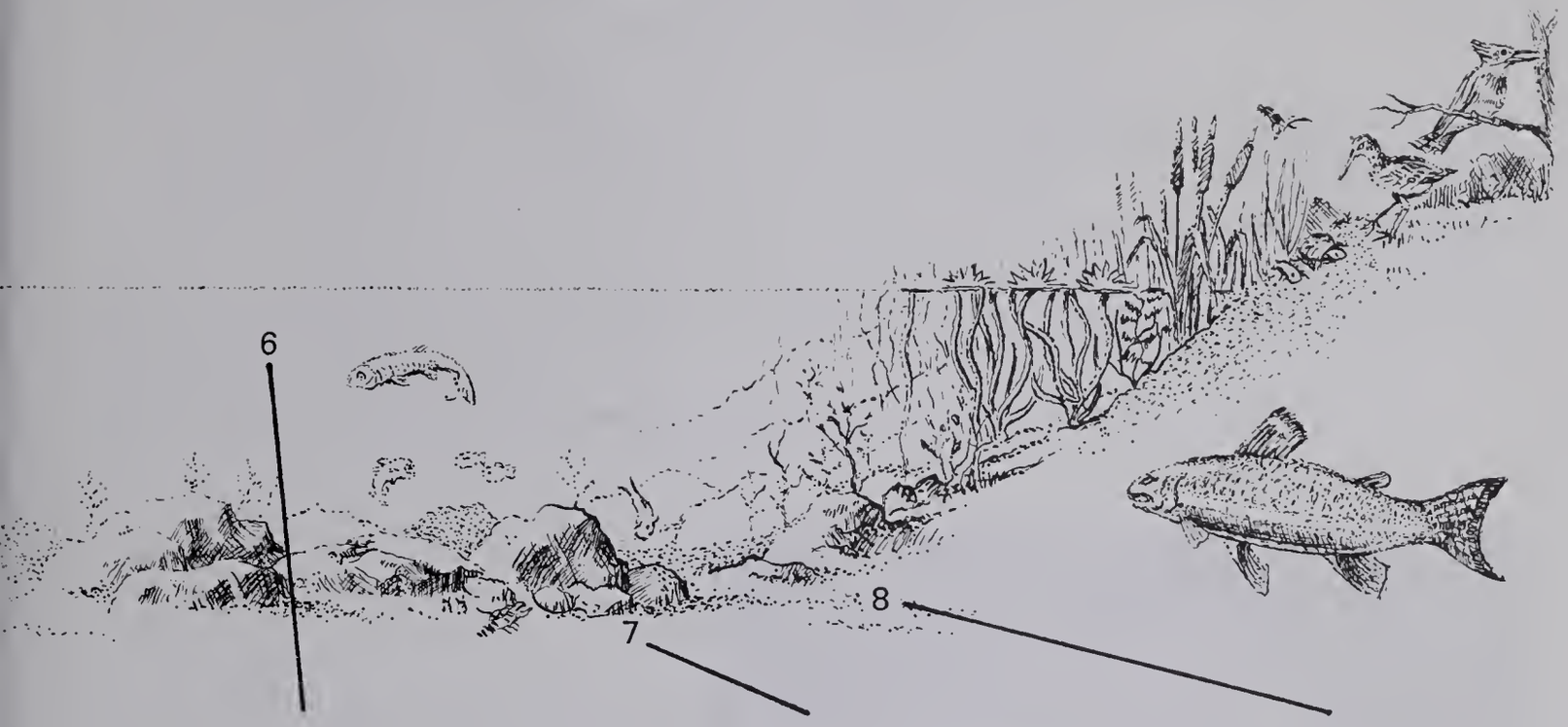
Use a kitchen sieve, pond net, or plankton net to catch surface dwellers.

Empty the contents of the sieve or net into white enamelled trays.

Transfer the animals into carrying jars containing wet weeds or a little damp moss.

Why should these animals not be placed in jars half-filled with water?

Label the carrying jars.



Drag the plankton net several metres upstream.

Remove the net from the water and turn it inside out over a white enamelled tray.

Wash the catch from the net into the tray. Use as little water as possible. Why?

Put the larger animals into carrying jars.

Put the water, along with any debris collected in the net, into separate carrying jars.

Label the carrying jars.

Pick up rocks from the bottom and examine all surfaces.

Use a paint brush to transfer the animals from the rocks to the enamelled trays.

Observe the animals briefly, and then transfer them into the carrying jars.

Do not put crayfish into the same jars. Why?

Label the carrying jars.

Scrape up the mud with a kitchen sieve or pond net.

Gently wash pond water through the sieve to get rid of excess mud.

Empty the contents of the sieve into a white enamelled tray.

Observe what you have found, and then transfer the animals into the carrying jars.

It is best to put the larger water insects into separate jars. Why?

Label the carrying jars.

WHAT SHALL WE DO WITH THEM?

Transportation

Handle all animals gently. Avoid bumping the carrying jars, particularly if there are stones in them.

Keep carrying jars away from direct sunlight. Why? If possible, place jars in an ice-cooled cooler.

Tops of carrying jars should have small air holes. Why?

Try to duplicate in the jars the habitat of the animal. For instance, add mud or stones or weeds and half jar of water. Which animal is suited to this? Remember! Do not cover air breathers with water. Use damp moss and weeds.

Do not overcrowd the carrying jars, particularly with the larger insects. Why?

Discuss with your teacher which animals and, just as important, how many animals or jars of animals you will take back to the classroom for further study. *Do not take away more than is absolutely necessary*. If you need more specimens of a particular animal, you can always return to the stream. Carefully put all the animals you will not require back into the water.

Keep a careful record of the date, the name of the pond or stream, and where (bottom? surface? bank?) the animal was found. It is easiest to put this information on a label and attach it to the carrying jar.

The tips on the preceding page will make sure that most of your animals will arrive back in your classroom in good health.

Classroom Care

Make comfortable homes for the animals you wish to watch and study. An aquarium would be suitable for the smaller animals found in locations 3, 4, 6, 7, and 8 in the diagram on pages 48 and 49. This should be set up two or three days before you collect the animals. If the aquarium is not ready when the animals are brought back to school, place the carrying jars in a refrigerator at a temperature of 4°C to 10°C for not more than two days.

Activity 2
MAKING A HOME FOR STREAM DWELLERS

MATERIALS

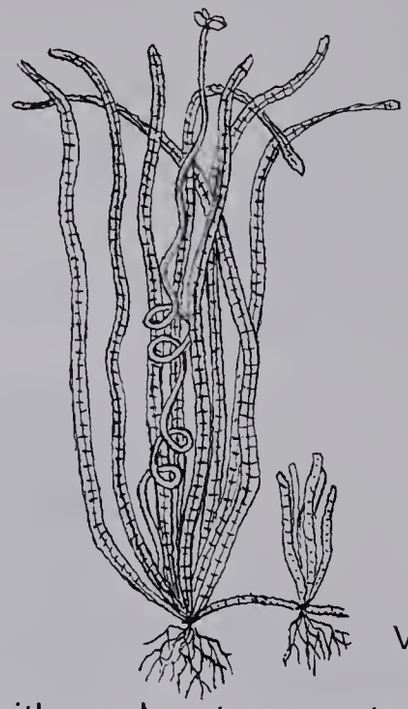
Large aquarium
Aerating pump
Mud, rocks, plants, and stream water

METHOD

1. Set up the aquarium with the mud and rocks and about 5 cm of water collected from the stream.

2. Add enough rocks at one end so that some will be above the final water level.
3. Replant some of the weeds collected at the pond or stream. Vallisneria and Elodea are very good for this purpose.

Elodea



Vallisneria

4. Carefully fill the aquarium with pond or stream water to about 5 to 7 cm from the top. If you pour the water slowly on to a piece of paper in the aquarium, you will not disturb the mud very much.
5. Make sure the aerating pump is running properly.
6. Let the aquarium sit for two or three days before adding animals.
7. Do not overcrowd your aquarium. In particular, do not place more than two or three of the larger insects in one aquarium. Also, do not place frogs, salamanders, large fish, or crayfish in such aquaria.
8. Knowing what to feed your animals may be a problem. Animals that live in the mud will probably find enough food in the mud of the aquarium. Many of the animals that live on and under rocks feed on algae plants growing on the rocks. Put fresh algae-covered rocks in your aquarium every three or four days.

Many of the larger water insects that inhabit the weeds, water, and water surface attack other animals for food. Feed these small bits of fish, meat, worms, and smaller insects, larvae such as mosquito larvae.

9. Study the chart which contains tips for solving aquarium problems.

Problem	Try This
Excessive growth of algae on the aquarium walls.	1. Move the aquarium further away from the sunlight. 2. Scrape away extra algae. 3. Include more pond snails.
Contamination or fouling of the water. (The water becomes discoloured and has a bad odour.)	1. Feed smaller amounts of food—less frequently. 2. Remove unused food. 3. Remove the remains of the larger dead insects.
Lack of oxygen in the water.	1. Use a larger aerating pump. 2. Add more pond weeds. 3. Check the water temperature. The best temperature for pond animals is between 10°C and 15°C, although temperatures up to 20°C will not be harmful.

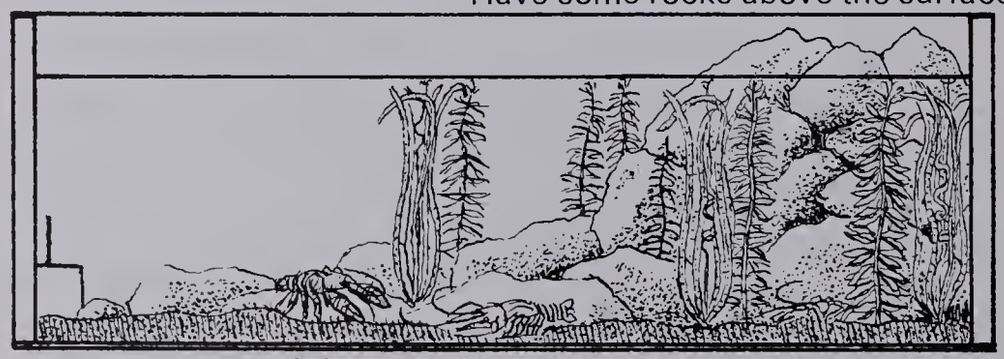
QUESTIONS TO TO THINK ABOUT

1. Why is it important to use stream water and not tap water in the aquarium?
2. Why should the aquarium be left undisturbed for two or three days before putting in the animals?
3. Why should no more than two or three large insects be placed in one aquarium?
4. Why should frogs, salamanders, large fish, and crayfish not be placed in an aquarium such as this?
5. Animals found in rapidly flowing streams usually die in an aquarium. Why?
6. If there is an excessive growth of algae on the aquarium walls, how will moving the aquarium further away from the sunlight help? How will including more pond snails help?
7. How will adding more pond weeds help if there is a lack of oxygen in the water in the aquarium?

A CRAYFISH HOME

Place a screened top on the aquarium.

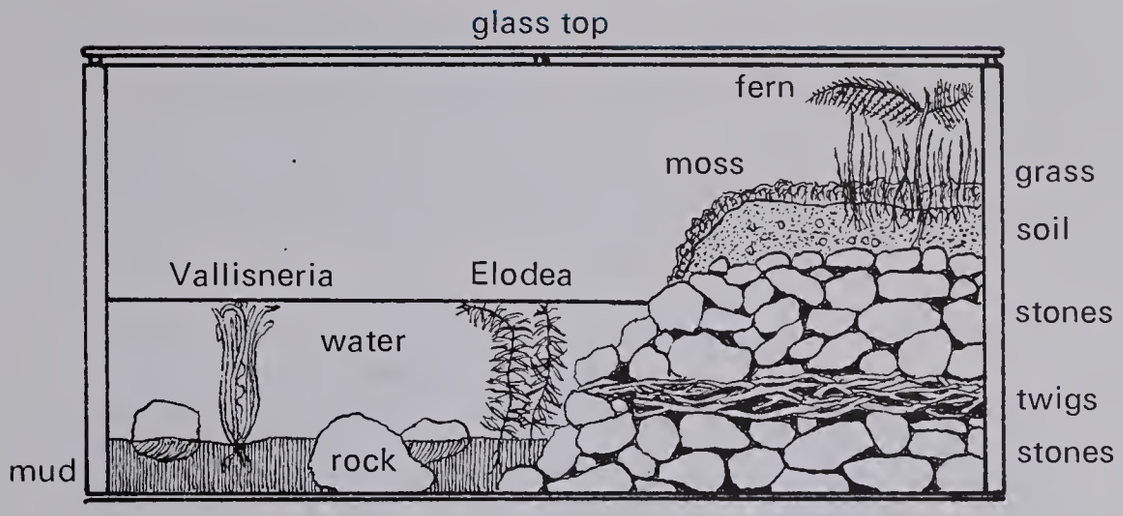
Have some rocks above the surface.



Add a small amount of mud.

Set up the aquarium as described in Activity 2, but use stone and rocks for the bottom instead of mud. Two or three small crayfish may be kept in such an aquarium. Remember to remove unwanted food after a meal. Follow the other tips suggested on page 53, and keep the aquarium in a cool place.

A HOME FOR FROGS, NEWTS, SALAMANDERS, TURTLES



a semi-aquatic terrarium

HELPFUL TIPS

1. Set up the semi-aquatic terrarium as shown.
2. Make sure that the water level of the aquatic part is below the soil line of the terrarium part. Why is this necessary?
3. The soil mixture should be three parts humus, one part gravel, and one part sand. It should be wet enough so that the mixture will cling together.
4. The size of the aquarium will determine the number of plants and animals to be included. Do not overcrowd the terrarium and do not put in large frogs, turtles, or salamanders.
5. You may want to include snails and aquatic insects in the aquarium portion.
6. The terrarium should be kept out of direct sunlight and at a temperature between 18°C and 22°C.
7. The loose-fitting glass top will keep the humidity in the semi-aquatic terrarium high. Why is this important? If moulds grow on the plants, replace the glass cover with a screen cover for part of the day.

FEEDING CHART

Crayfish	Frog	Salamander or Newt	Turtle
Living food	*Living food*	*Living food*	*Living food*
insect larvae and nymphs	June bugs	earthworms	earthworms
worms	cockroaches	young snails	tadpoles
small fish, occasionally	flies		insect larvae and nymphs
	grasshoppers		
	caterpillars		
	earthworms		
Dead food	*Dead food*	*Dead food*	*Dead food*
bits of fish or raw meat.	lean beef	chopped earthworms	fish
To attract the crayfish, dangle the bits on a thread.	liver	ground lean beef	ground meat
	Dangle the food on a thread to make it appear alive.	liver	vegetable matter

All the animals are fed under water except for the frog. They may be fed daily, but the newt may require food only two or three times a week.

Remember to remove all traces of unwanted food from the water. If this is not done the food will decay quickly and pollute the water. It is sometimes best to remove the animals from the aquaria or semi-aquatic terraria and feed them in separate feeding dishes. Use pond water at the same temperature as the aquaria water. Rinse the animals before returning them to the aquaria.

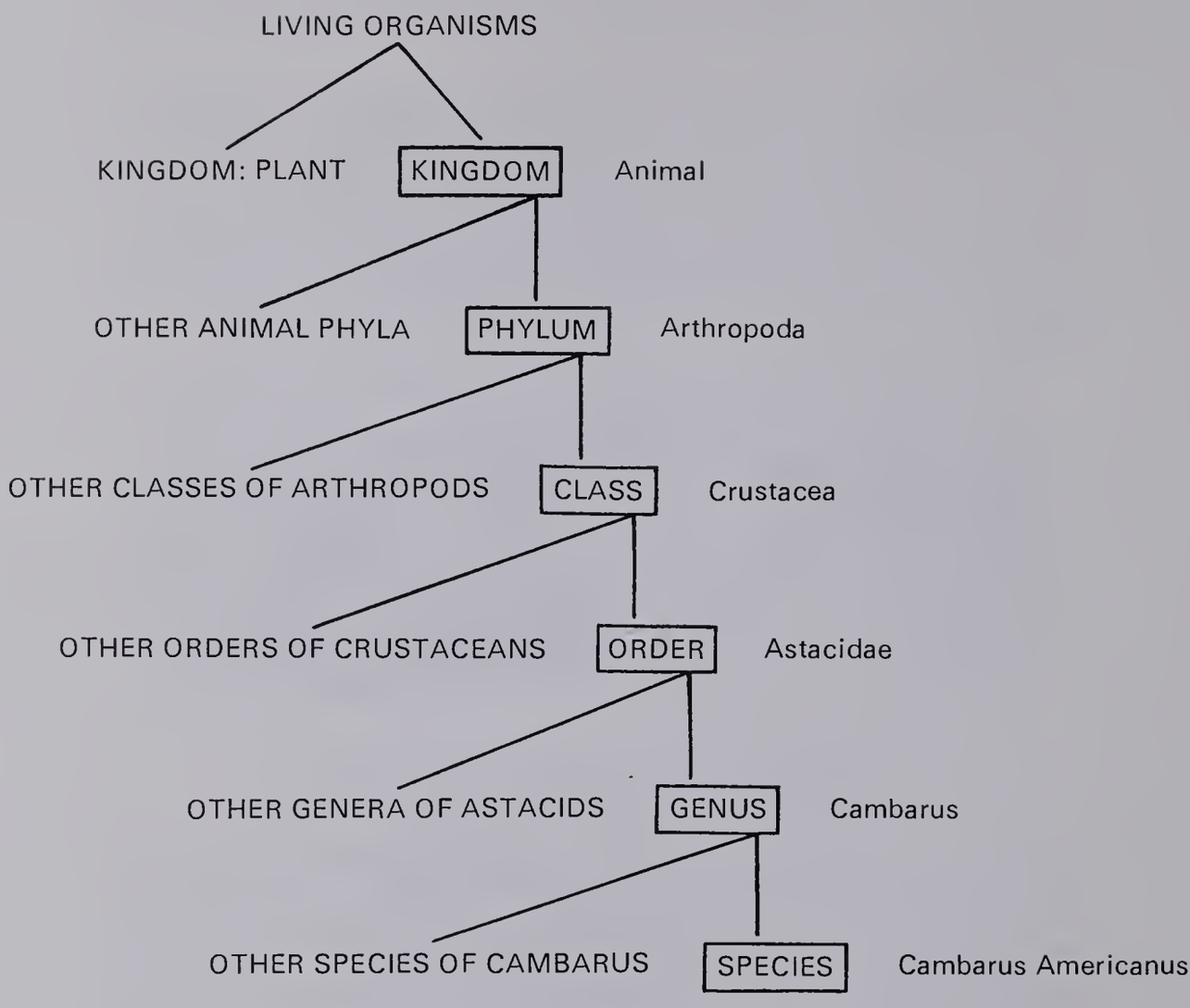
WHAT DID WE CATCH?

After making a catch, one of your first questions will probably be, "What is it?" To simply name a plant or animal is, in itself, not very valuable. It is much more meaningful—and exciting—to discover how an animal is suited for and survives in a certain part of the stream or pond.

However, there will be many times when you will want to compare your discoveries with those of others, or to learn more about a certain group of animals. Then it will be helpful to be able to identify some of your animals.

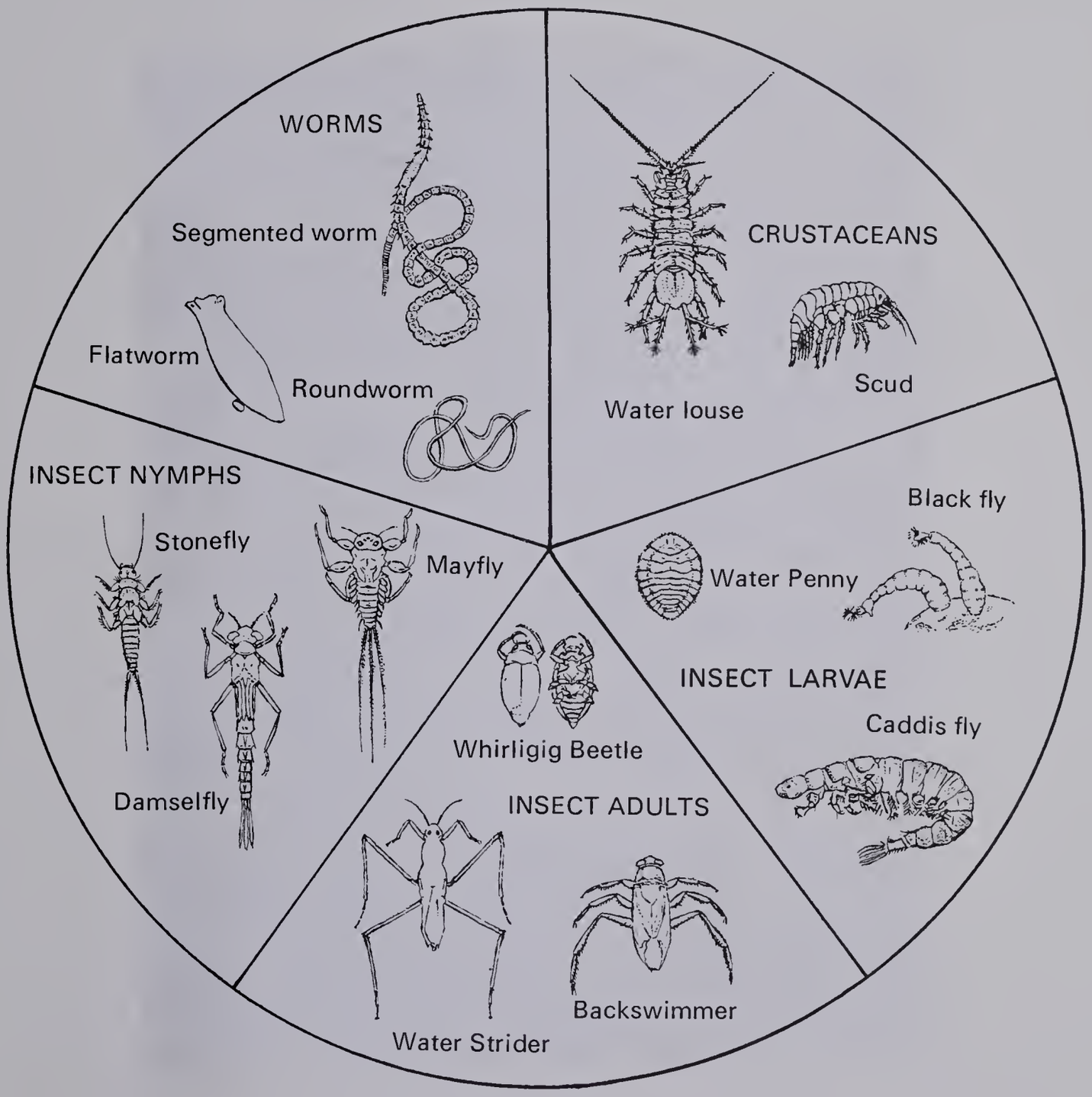
Animals which have many similar characteristics and which breed together form a *species*. Species with many similarities are grouped together in a *genus* (plural, *genera*). Similar genera are grouped into a *family*, similar families into an *order*, similar orders into a *class*, and similar classes into a *phylum* (plural, *phyla*). The animal phyla make up the Animal Kingdom. Look at the example on the following page for the classification of the crayfish.

CLASSIFICATION OF THE CRAYFISH



Cambarus Americanus

Only a few representatives from some of the animal phyla are illustrated in this book. The reference books listed on page 124 will be used for further identification.

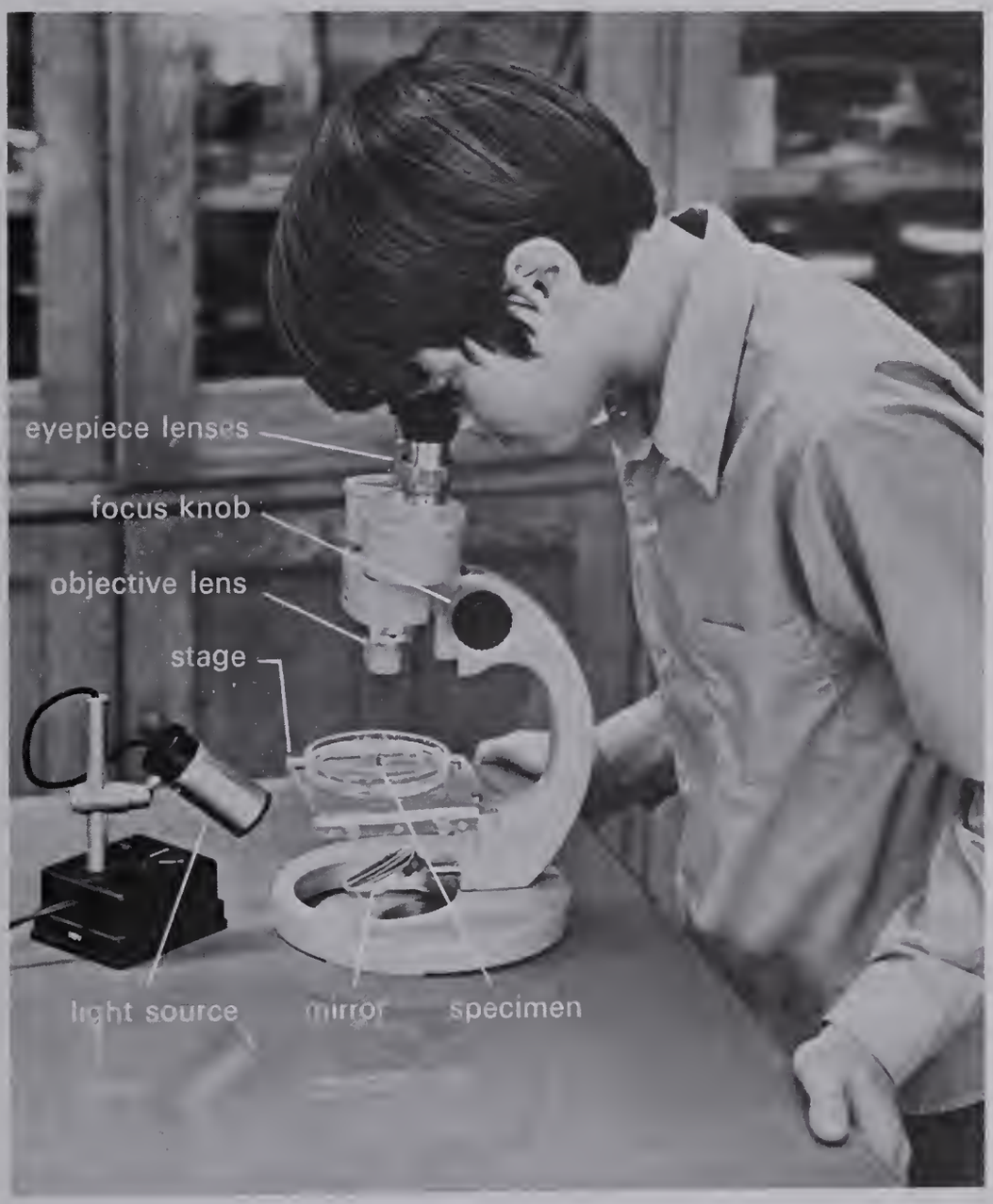


WHAT SHALL WE LOOK FOR?

You will spend many fascinating moments watching the activities of your pond and stream dwellers. The crayfish, turtles, frogs, and salamanders in the semi-aquatic terraria can be seen with the naked eye. Larger insects, worms, leeches, and snails in

the aquaria are also easily seen. There will be times, however, when you will need an enlarged view of a particular animal. If you place the animal in a small dish of water to restrict its movement, you can view it with a magnifying lens.

Animals too small to be seen clearly with the naked eye or a magnifying glass may be viewed under a stereo microscope or a standard microscope.



A stereomicroscope

By changing the objective lens, you can get different magnifications. For example, if the eyepiece lenses are ten power (10x) and the objective lens is two power (2x), the total magnification would be 10 x 2 or 20 times. What would be the magnification if the eyepiece lens were 15x and the objective lens 4x? Use lower magnification for larger or more active animals and higher magnification for smaller or less active animals. The stereo microscope is also excellent for viewing parts of dead animals. The dish which is placed on the glass stage must also be glass, or plastic. Why? A dish with low sides will let you handle the animal more easily with tweezers (be gentle!) or a probe.

HABITS OF AQUATIC ANIMALS

Activity 3
LOOKING AT PLANKTON

Plankton are organisms which float beneath the surface of the water. Some can be seen by the naked eye, but many are microscopic. They depend mainly on the water current for movement, although some are able to propel themselves.

Plankton are single-celled plants and animals, some algae colonies, rotifers, water fleas, seed shrimps, and a group called copepods. They are food for many animals.

MATERIALS

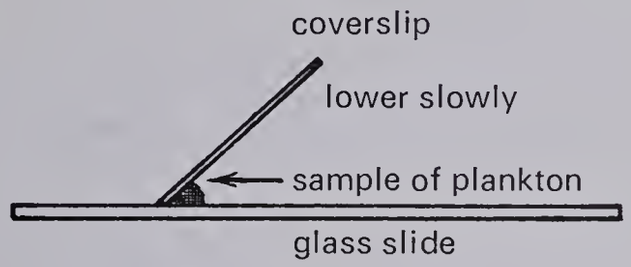
Standard microscope
Eye dropper
Glass slide and coverslip
Glycerine

METHOD

1. See page 47 for a method of collecting plankton. You will find both animal and plant plankton, but for this activity,

concentrate on the animal plankton. Activity 3 in Chapter 5 will introduce you to plant plankton.

2. Place two or three drops of the plankton sample on a glass slide.
3. Lower the coverslip so that one edge touches the edge of the sample on the slide. The sample will run along the edge of the coverslip.

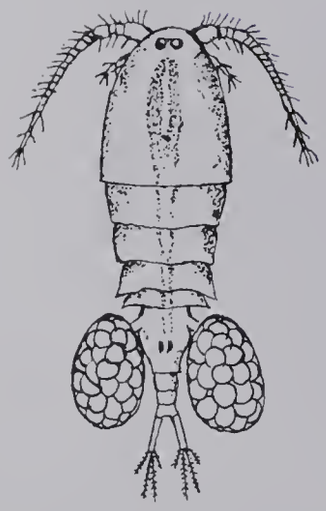


4. Lower the other edge of the coverslip slowly so that it rests on the glass slide. The water and plankton under the coverslip should be spread evenly and there should be no air spaces.
5. If you find after focusing the microscope that the animals move too quickly to be seen clearly, add one or two drops of glycerine to the slide sample. Glycerine makes the liquid thicker and slows down the movement of the animals.

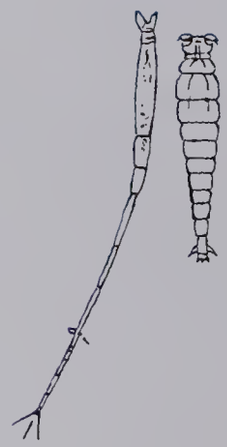
On the following page are some of the organisms you may find.

Some of the activities described in this chapter will lead you to discover how various stream animals catch and eat their food, move to escape predators, breathe, reproduce, and grow. The number of extra activities that you can carry out is limited only by your imagination. You may think of ways to see if your study animal can detect light, sound, or chemicals (such as salt, sugar, or vinegar) or how it moves in darkness, and so on.

Type of Animal	Example
Single cells with many hair-like cilia.	Vorticella, Paramecium
Single cells with a long whip-like flagellum.	Peranema
Very small animals composed of many cells.	Rotifers and many types of small crustaceans such as daphnia, the water flea; cypridiopsis, the seed shrimp; and cyclops.

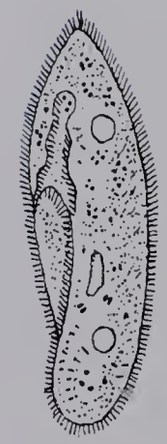


Cyclops

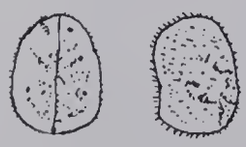


Rotifer

Vorticella



Paramecium



Seed Shrimp

Peranema

Water Flea

BREATHING

Animals must breathe in order to supply themselves with oxygen. Oxygen is necessary for the cells of an animal to produce energy for doing various types of work. Animals must also get rid of the carbon dioxide and other wastes which are produced by the cell as it provides itself with energy and does work. This energy-producing process that takes place in the cell may be written like this.

$$\text{Oxygen} + \text{Certain types of food} \xrightarrow{\text{produces}} \text{Energy} + \text{Water} + \text{Carbon Dioxide}$$

$$O_2 + C_6H_{12}O_6 \longrightarrow \mathcal{E} + H_2O + CO_2$$

There are two main sources of oxygen for a stream: oxygen dissolved in the water and oxygen in the air above the water surface. Some animals get their oxygen from only one of these sources, while others can take oxygen from both. A few water animals can puncture underwater plant stems to obtain oxygen from the air spaces inside.

Activity 4
GETTING OXYGEN

MATERIALS

Living specimens
Diagrams given
Resource centre—reference books, pictures, filmstrips, film loops

METHOD

1. Look at the following diagrams. You will probably have collected some of these animals. Watch them closely to see if you can discover how they are getting oxygen.

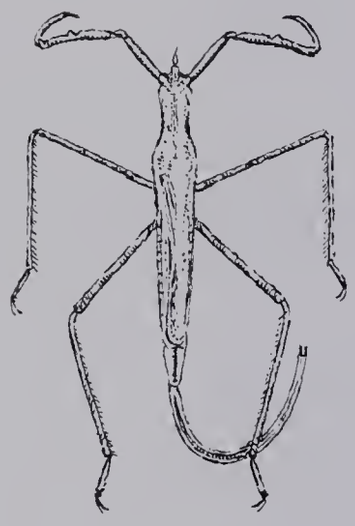
caddis fly larva
(Hydropsyche)

hover fly larva
(Tubifera)

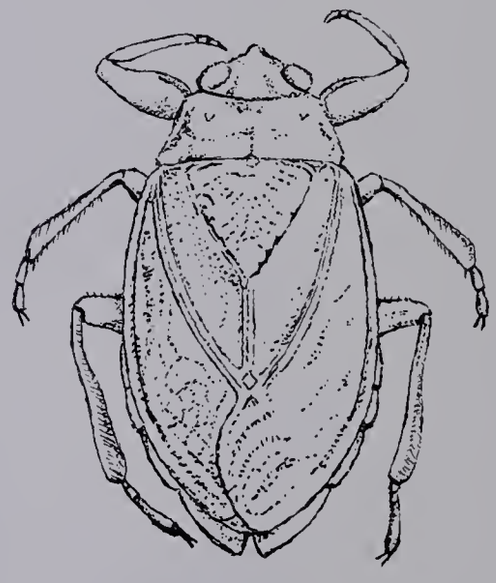
segmented worm
(Tubifex)

mosquito larva
(Culex)

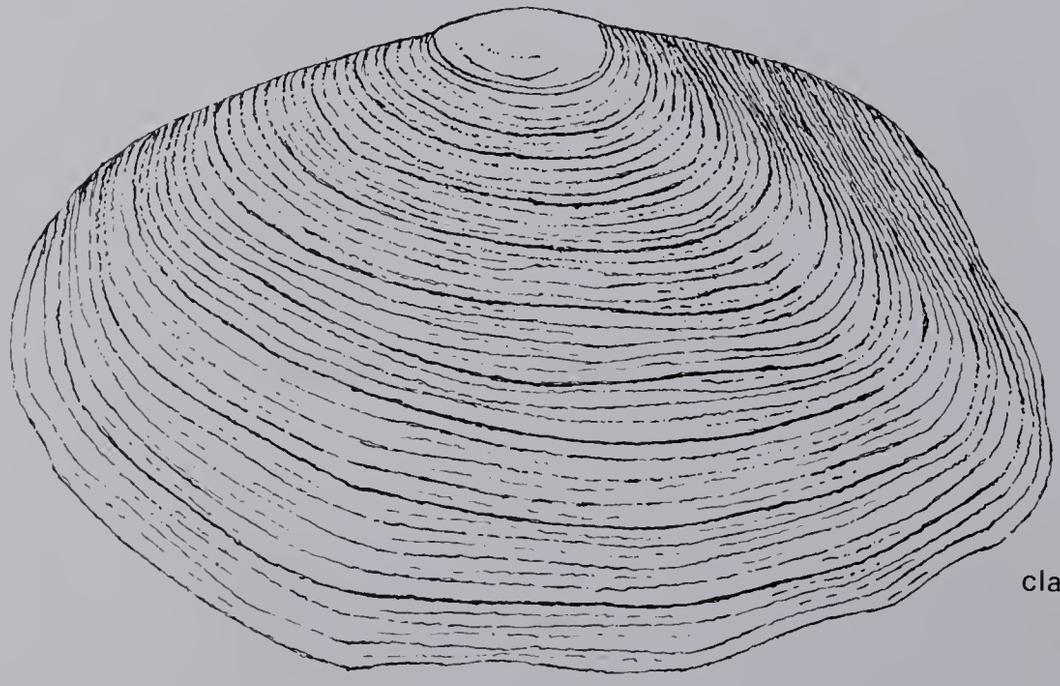
mayfly nymph (Hexagenia)



water bug (Ranatra)



giant water bug (Belostoma)



clam (Elliptio)

2. Use materials at your resource centre or library to determine how these animals are getting oxygen. Were your observations correct?

Other animals you may wish to investigate are: an adult frog, a water bug called the water boatman, a water snake, a beetle larva called Donacia, a whirligig beetle, a leech, a fish, a turtle, a crayfish, a stonefly nymph, and a midge larva called Tendipes or Chironomus.

QUESTIONS TO THINK ABOUT

1. One way to eliminate the mosquito is to spray marshes, swamps, and ponds with a film of oil. How would this eliminate the mosquito?
2. How would this cause pollution?
3. Of the animals mentioned in this activity, which ones might be able to survive in polluted water which contains very little dissolved oxygen? Why?

Activity 5
OBSERVING BREATHING

MATERIALS

Three mayfly nymphs (Hexagenia is a good type for this activity because of the large gills on the abdomen.)
Three culture dishes
Pond water
Thermometer
Magnifying lens or stereo microscope

METHOD

1. Half-fill the culture dishes with pond water.
2. Add ice cubes to one of the dishes to bring the water temperature down—between 4°C and 10°C.

3. Add a little more pond water to the second dish, keeping the water at room temperature—between 18°C and 21°C.
3. Add warm water to the third dish to make the water temperature about 32°C. Make sure that all three dishes are about three-quarters full.
5. Place one mayfly nymph in each dish.
6. With the aid of a magnifying lens, observe the action of the gills of the mayfly nymphs in each of the three dishes.

A Mayfly Nymph

FIND THE ANSWERS

1. What differences were there in the gill action of the mayfly nymphs?
2. Why was there a difference? (See Chapter 3, Activity 6 for a hint.)
3. When you place stream dwellers having gills in small containers of water to study them, what should the water temperature be? Why?

Try this activity with other stream insects having gills and compare your results.

Activity 6
OBSERVING FISH BREATHING

MATERIALS

Fish in an aquarium or a small glass bowl of pond water
Magnifying lens or stereo microscope (low power)

METHOD

1. Find the mouth and gill slits of the fish.
2. Watch the movement of the mouth and the gill covers.
3. Raise the temperature of the water (but not above 32°C.) and watch carefully. Lower the temperature and continue watching.

RESULTS

1. From your observations, how does the fish pass fresh water over its gills?
2. Why is this important?
3. What was the effect when the pond water was cooled? Why?
4. What was the effect when the pond water was warmed? Why?

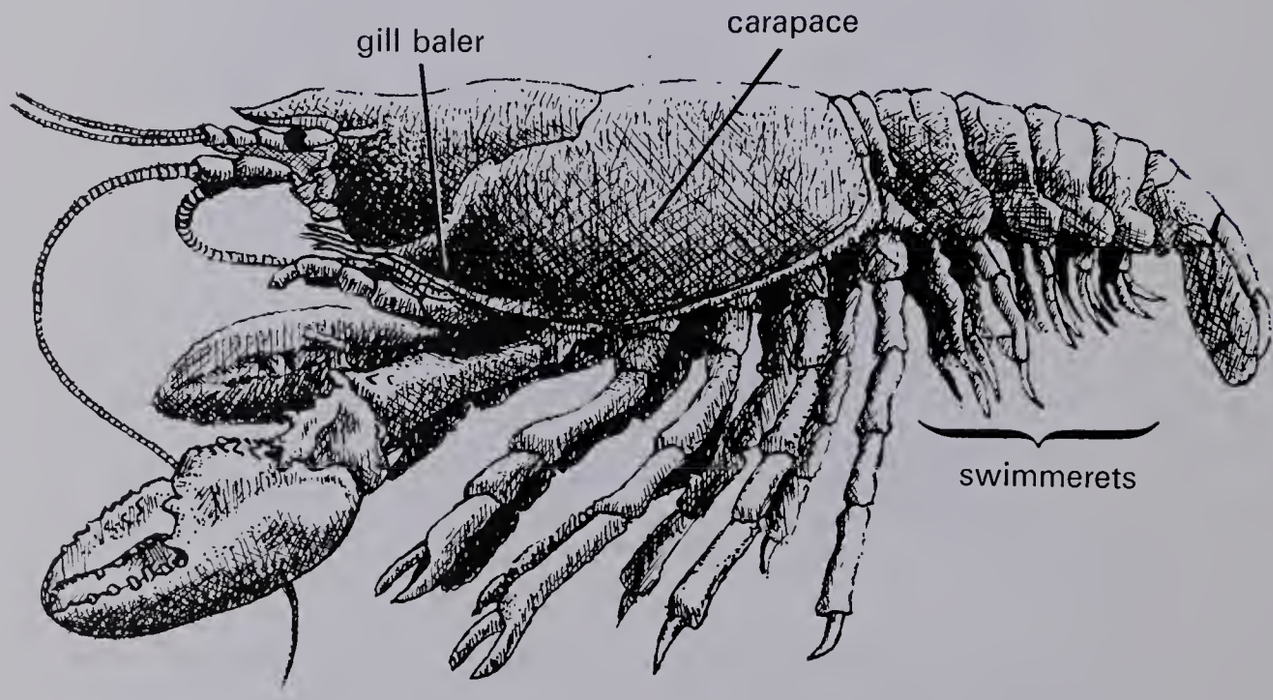
Activity 7
OBSERVING CRAYFISH BREATHING

MATERIALS

Crayfish in a small bowl of pond water
Medicine dropper
India ink

METHOD

1. Slowly lift the bowl above your head so that you can see the crayfish from the underside.
2. Describe any movements which you think may be related to breathing.



3. Add one drop of India ink with a medicine dropper near the side of the crayfish's abdomen. Observe the movement of the stained water.

4. Observe the breathing movements from the underside again when the water has been
   (a) cooled with ice;
   (b) heated with warm water.

RESULTS

1. From your observations, where do you think the gills of the crayfish are located? Check in a reference book.
2. From your observations, how does the crayfish pass water over its gills? Check in a reference book.
3. What effect did a change in water temperature have on the breathing movements? Why?

MOVEMENT

Stream animals must find food, escape their enemies, and reproduce the next generation. Moreover, since they cannot survive great changes in their environment, they must have an efficient means of locomotion. There are many solutions to the problem of movement in or on water.

Activity 8
OBSERVING WAYS OF MOVING IN THE STREAM

MATERIALS

Aquaria containing specimens collected from a slow-flowing stream or pond

METHOD

Watch these organisms to see how they move. As you watch, try to find two animals for each type of movement listed here. Draw a diagram of the animal if you cannot identify it.

Type of Movement	Animal
1. Swimming in the water.	1. 2.
2. Crawling on the bottom mud or rocks, or on water plants.	1. 2.
3. Gliding on bottom stones, debris, water plants, or the walls.	1. 2.
4. Burrowing in the bottom mud.	1. 2.
5. Swimming on or just under the water surface.	1. 2.
6. Walking on the water surface.	1. 2.

Activity 9
OBSERVING FISH SWIMMING

MATERIALS

Fish in an aquarium or fish bowl

METHOD

Carefully watch the movement of the body and fins as the fish swims forward, stops, backs away, and hovers.

WHAT DID YOU OBSERVE?

Use materials at your resource centre to find the answers.

1. How does the fish move forward quickly?
2. How does the fish move forward slowly?
3. What fins does it use to move backward?
4. How does it slow down or stop?
5. What fins does it use to balance as it hovers in one spot?

6. What fins stabilize the fish as it moves either forward or backward?
7. What fins help to control the angle at which it dives or moves to the surface?

Activity 10
OBSERVING CRAYFISH MOVEMENT

MATERIALS

Crayfish in an aquarium or semi-aquatic terrarium (See page 54.)

METHOD

1. Watch carefully as the crayfish walks among the rocks of the aquarium. Observe what appendages are used.
2. Put a stick suddenly in front of the crayfish and see how it swims.
3. Take the crayfish out of the aquarium and see how it walks on the flat surface of a desk top.

WHAT DID YOU OBSERVE?

1. What appendages are used for walking?
2. In which directions can the crayfish walk?
3. Is walking easier in the water than it is along the shoreline (or your desk top)? Why?
4. In what direction does the crayfish swim?
5. How does it swim?

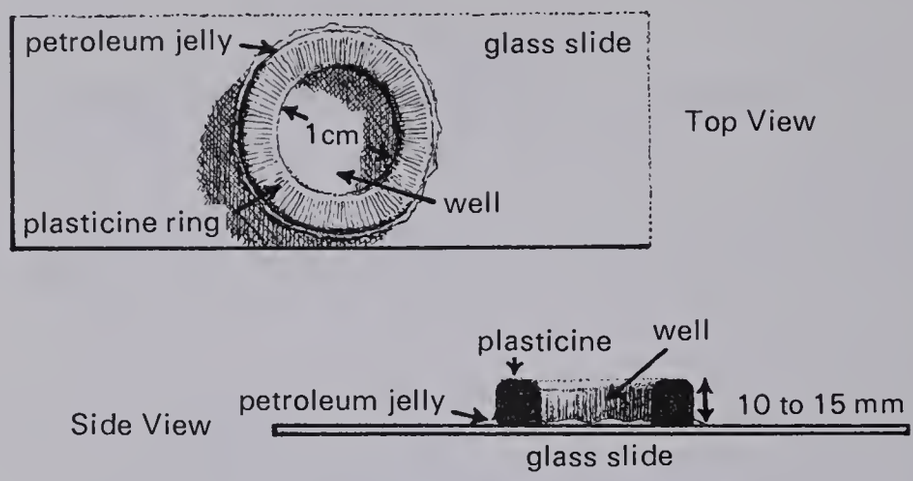
Activity 11
WATCHING GLIDERS

MATERIALS

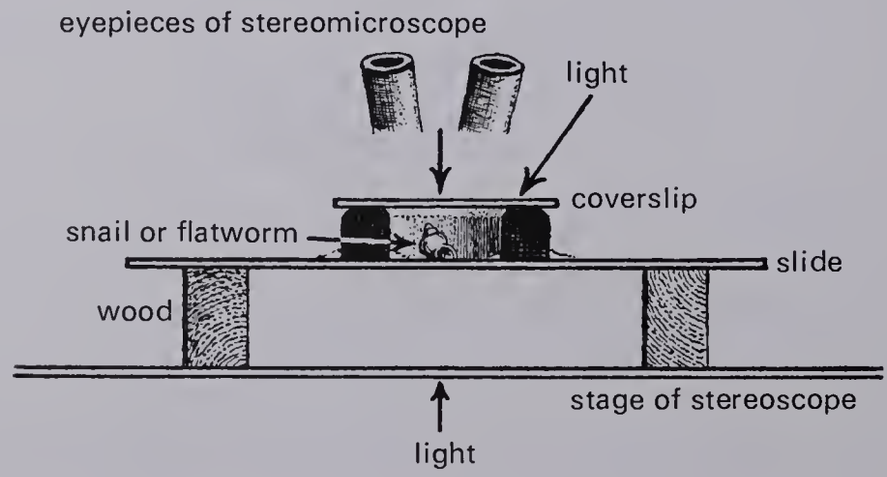
Pond snails
Flatworms (Planaria)
Glass slide and coverslip
Plasticine
Petroleum jelly
Pond water
Magnifying glass or stereo microscope

METHOD

1. Build a ring of plasticine on a glass slide as shown. The ring should be 10 to 15 mm high all around.



2. Make sure that the bottom of the ring is pressed firmly against the glass slide. Coat with petroleum jelly as shown in the diagram. Why do you think this is done?
3. Fill the "well" with pond water.
4. Place one pond snail or flatworm in the well, then cover the well with a coverslip. The petroleum jelly should hold the coverslip to the plasticine when the slide is turned upside down.
5. Place the glass slide on two small blocks of wood, as shown, so that you can turn it over and watch the animal as it glides across either surface.



WHAT DID YOU OBSERVE?

1. How do snails and flatworms move across surfaces?
2. Can a flatworm swim? Set up an activity to show whether it can or can not.

Activity 12
OBSERVING OTHER WAYS OF SWIMMING

MATERIALS

A dragonfly nymph
A damselfly nymph
A mayfly nymph
A white enamelled pan with pond water
India ink
Medicine dropper

METHOD

1. Watch how each of the three types of nymph swims. Pay careful attention to the action of the abdomen.
2. Place a few drops of India ink near the tip of the abdomen of the dragonfly nymph and watch.
3. Using both your observations and information from your reference books, describe how these three types of insect nymph swim.

Activity 13
MOVEMENT IN A FAST-FLOWING STREAM

MATERIALS

Insect larva or nymph collected from the rocks on the bottom of a fast-flowing stream
Culture dish
Magnifying lens or stereo microscope

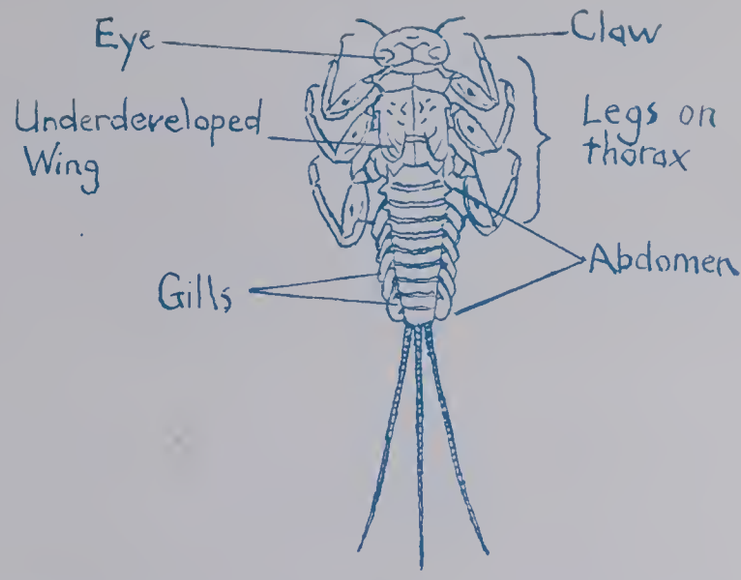
METHOD

1. Recall how difficult it was to remove from the rocks some of the animals that were collected from the fast-flowing stream. Why was it difficult? How could some of the animals move across the rock without being swept away by the current?
2. Examine carefully in a culture dish any one specimen which you think is well suited to living on or under a rock in fast-flowing water. Use a magnifying lens or stereo microscope.
3. Compare your results with those of a grade six girl who examined a mayfly nymph.

Project

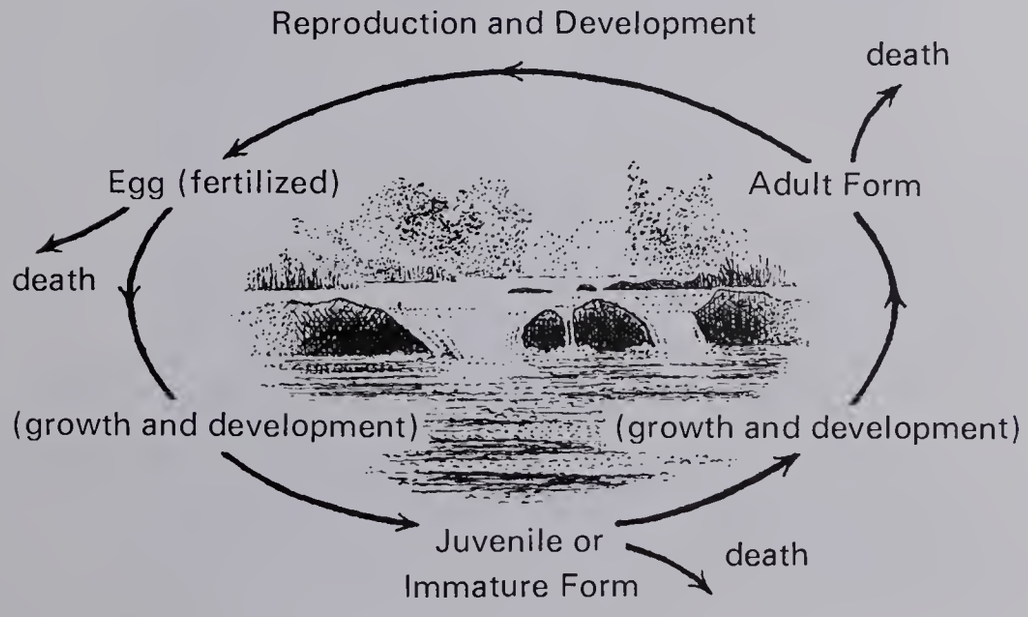
Date - May 20, 1971
Stream - Willow Creek
Location of Specimen - The mayfly nymph was crawling on the underside of a rock that was about 20 cm below the water surface. The speed of the water was calculated at 1 m/s
Problem - Why was the mayfly nymph not swept away from the rock?
Results of Examination

Characteristics of the mayfly nymph	Advantage
1. It is flattened from back to front, including the head.	The insect is very close to the surface of the rock.
2. Its three pairs of legs extend to the side of the thorax and not underneath.	Its body can be flattened against the rock surface even when it is crawling.
3. There are small hooks or claws at the end of each leg.	It can hold on to the rock.
4. Small feather gills extend from the side of the abdomen behind the legs.	Water can pass over the gills and the insect can get oxygen.
5. The eyes are on the upper front surface of the head.	It can see objects above it and in front of it.



REPRODUCTION AND DEVELOPMENT

Many stream-dwelling animals pass through stages or a life cycle like the one shown in the diagram. You can see that if the adults did not produce a new generation, animal life at the stream would quickly die out.



The juvenile or immature form of many animals looks very much like the adult form. In other animals, though, the immature form looks completely different.

Also, the various stages of development may take place in different habitats. The eggs may be found in the water, on the bottom mud, on stones, on water plants, in water plants, on the surface, and, in some cases, on other animals. The juvenile forms may be found in various locations in the water or on the land, and the adult forms may be found in the water, on the land, or in the air.

Activity 14
WRITING LIFE HISTORIES OF SOME STREAM AND POND ANIMALS

MATERIALS

Reference books, flat pictures, filmstrips, film loops, resource people, visits to museums, high schools, and universities, to be used to investigate the life histories of some of the following animals.

Animals To Research

snake	mayfly
bullfrog or toad	mosquito
newt or salamander	giant water bug
turtle	crayfish

METHOD

1. Choose one of the animals from the list above, and imagine yourself being that animal.
2. Write your autobiography, or life history.
3. Include a description of the forms or stages you pass through, and of your home and favourite food at each stage. Record the amount of time you spend in each stage and any other interesting information about yourself.
4. A photograph or portrait of yourself would be helpful.

Activity 15
WATCHING TOADS DEVELOP

MATERIALS

Aquarium with aerating pump
Semi-aquatic terrarium
Finger bowls with pond water
Magnifying lens or stereo microscope
Pail and dipper

METHOD

1. Set up your aquarium and semi-aquatic terrarium as described in Activity 2 on page 51. There should be no other animals which might eat the eggs in the aquarium and terrarium.
2. There should be several algae-covered stones and aquatic weeds in the aquarium.
3. In late April or early May visit the pond or slow-flowing stream and look for toad eggs. Remove some strands carefully with a dipper and carry them back to your classroom in a pail half-filled with pond water.

4. Place a strand of between 18 and 24 eggs in the aquarium. The temperature should be maintained at 21°C to 21.5°C once the eggs have been put in. The remaining strands of eggs can be distributed in several finger bowls of pond water and used as a reserve supply.
5. Watch your eggs carefully. They should turn dark all over. If they turn a white colour, they are dead. Take them out so that they do not pollute the water.
6. When you see that the eggs are developing, return your reserve supply to the pond. Why?
7. Every day make notes and diagrams of all changes. Be sure to record the date. Use your magnifying lens and stereo microscope to see the features of the developing tadpoles when they leave the eggs. As the tadpoles develop, try to discover how they move, breathe, and eat.
8. Continue keeping the records as the tadpoles change into adults. The larger tadpoles can be fed from time to time—bits of hard-boiled egg, finely chopped beef, and bits of tulip leaf which have had the skin (epidermis) removed from one surface. Add fresh mud and algae-covered rocks every week or so.
9. When your tadpoles have become miniature adults they may be put into the semi-aquatic terrarium.
10. Reference books may be used in either of two ways. You can read about toad development as your activity is progressing, which will help you to know what to look for. On the other hand, sometimes it is more fun if you carry out the activity and then check with the reference books to compare your notes and diagrams with those in the books.

QUESTIONS FOR STUDY

1. What is the difference between a frog and a toad?
2. How do adult frogs and toads survive the winter?
3. How long does it take for the green frog and the bullfrog to develop from the egg stage to the adult?

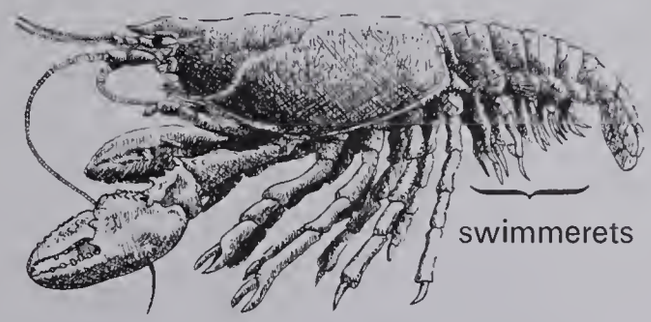
Activity 16
WATCHING CRAYFISH DEVELOP

MATERIALS

Semi-aquatic terrarium
Magnifying lens or stereo microscope

METHOD

1. On stream and pond visits in the late autumn or early spring, look for female crayfish carrying eggs on their swimmerets. Bring one back to your semi-aquatic terrarium or crayfish aquarium.



2. Watch the development of the eggs and make a record of any changes that occur.
3. When the young crayfish leave the swimmerets they should be placed in a separate aquarium or semi-aquatic terrarium, or returned to the stream or pond.

Activity 17
WATCHING INSECTS DEVELOP

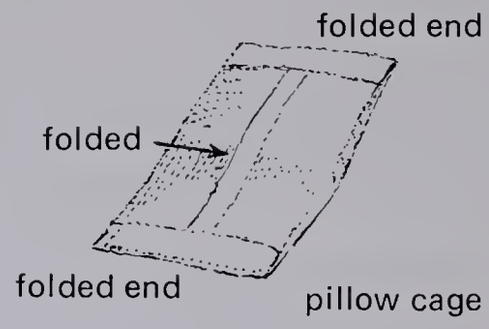
MATERIALS

A pillow cage
An aquarium
A white enamelled pan
Larvae of midges or mosquitoes, or nymphs of dragonfly, damselfly, or mayfly

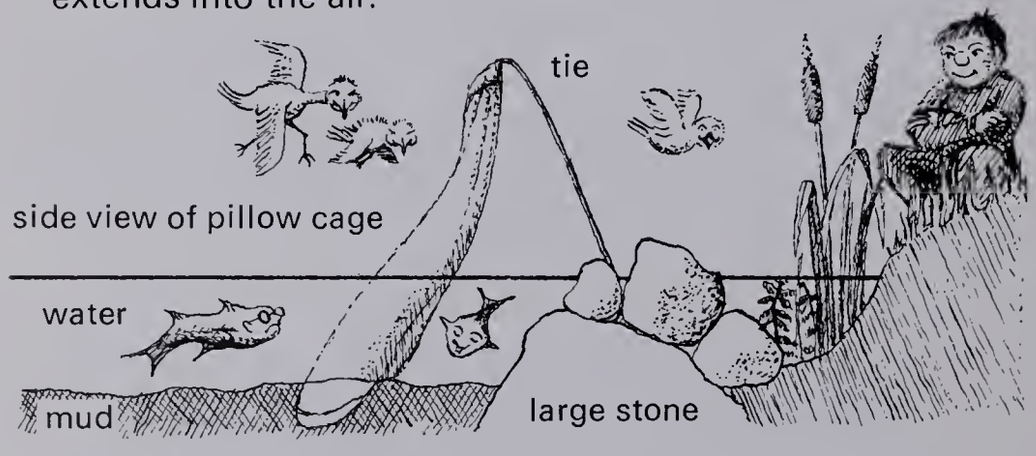
There are several ways that you can watch insect larvae or nymphs change into adults.

METHOD A

1. Construct a pillow cage from a square piece of ordinary screening.



2. Place mud, algae-covered stones, and decaying plant matter from the pond bottom in one end of the pillow cage.
3. Place the larvae or nymphs in the cage. Fold the open end of the cage closed.
4. Place the pillow cage at the stream's edge so that the bottom of the cage containing the mud and insects is partly submerged in the water and the top two-thirds of the cage extends into the air.



5. Anchor the cage to a rock placed nearby.
6. Check every day to see if any flying adults have emerged.
7. If you know from reference books the time of year that certain insect larvae and nymphs emerge, you can choose insects which will emerge within a week or two of setting up the pillow cage.

METHOD B

1. You will need to place emergent vegetation (plants which grow out of the water into the air), small sticks which protrude above the water surface, or pieces of floating styrofoam in the aquarium. The larvae and nymphs of some insects move out of the water on to a dry surface before changing into the pupa and/or adult forms.
2. Build a screen roof for your aquarium.
3. Place the larvae or nymphs in the aquarium and watch for the emerging adults.

METHOD C

You may also use a white enamelled pan containing pond water and about 7 cm of pond mud to watch insect development. Floats must be provided and the pan covered with mosquito netting. This arrangement is good for dragonfly, damselfly, and mayfly nymphs as well as midge and mosquito larvae.

A dragonfly nymph was brought into the classroom in autumn, lived in this pan of water through the winter, and in spring emerged as a flying adult.

Use your resource centre to read about the life histories of the insects with which you are working.

1. What is insect "metamorphosis"?

2. What is the difference between "complete" and "incomplete" metamorphosis?
3. What is the difference between an insect larva and an insect nymph?
4. What is the purpose of the "pupa" stage?
5. What do the words "insect emergence" mean?

Activity 18
WATCHING THE REGROWTH OF NEW PARTS

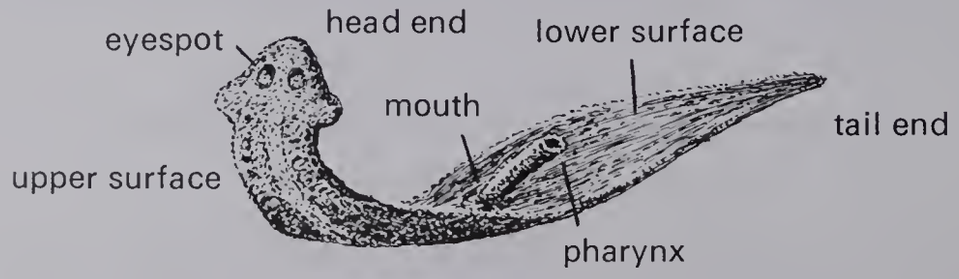
Perhaps you noticed that some of the crayfish you caught had one of their large pincers much smaller than the other. The smaller appendage was probably one that had regrown when the first one was lost in a fight or caught on a rock. Some stream dwellers have remarkable powers to regenerate (grow new parts).

MATERIALS

Culture dishes and pond water
Flatworms (Planaria)
Razor blade
Magnifying lens or stereo microscope

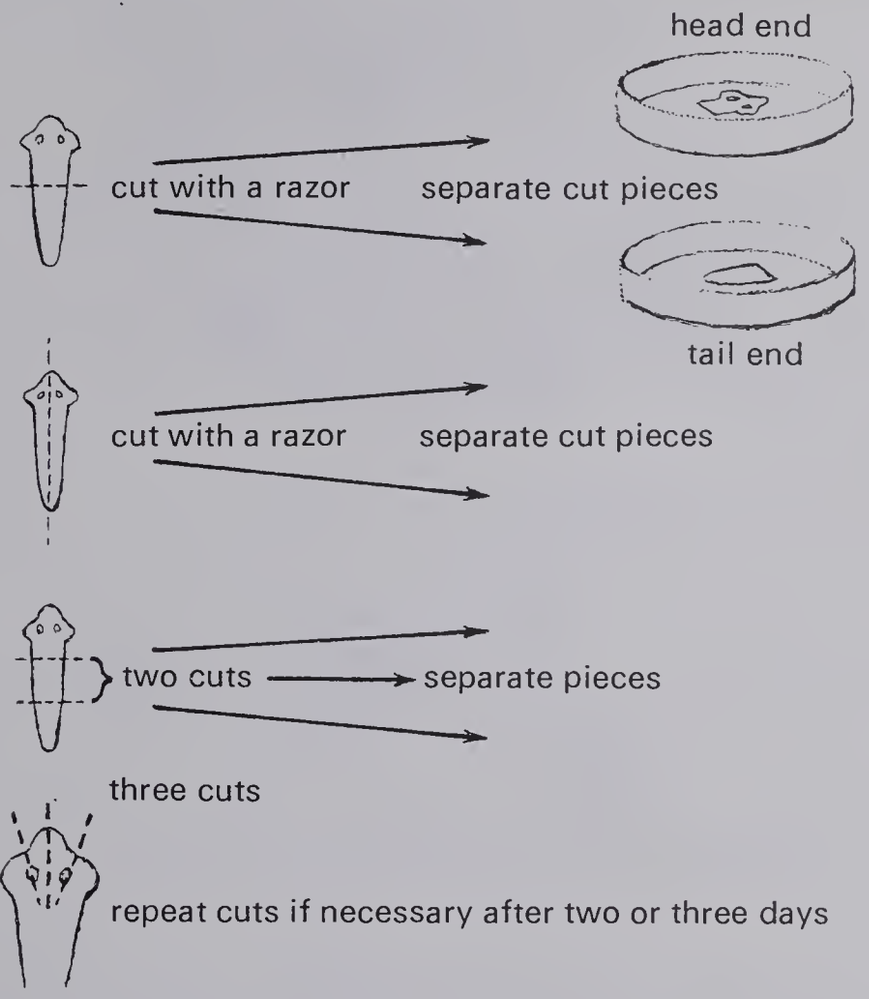
METHOD

1. Watch a planarian (flatworm) glide over the surface of a culture dish filled with pond water. Look for the following parts.



To see the pharynx extend from the mouth, turn a planarian upside down in a drop of water on a glass slide and hold a small piece of juicy beef liver near the mouth. Planarians can be fed beef liver about once a week.

2. To see regeneration, perform the following operations.



3. Make daily observations of your cut planarians. Feed the cut pieces every five or six days as you would whole worms.
4. Be sure to keep the water in the dishes cool (around 15°C. If possible) and free from contamination. Unused liver should be removed immediately and fresh pond water added to the dishes every two or three days. Keep the dishes in a cool, dark place (such as a fruit cellar).

OTHER INVESTIGATIONS

1. How do planarians react to direction of light?
2. How do planarians react to direction of water current?

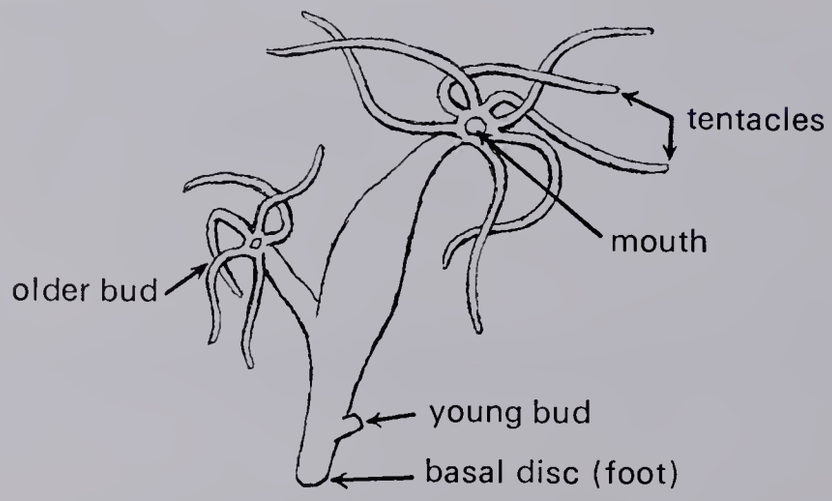
Activity 19
WATCHING ANOTHER WAY OF REPRODUCING

MATERIALS

Hydra (The hydra may be found on bottom stones or hanging from underwater plants and lilypads.)
Aquarium or glass jar with pond mud or weeds
Magnifying lens

METHOD

1. Look for the following in your hydra.



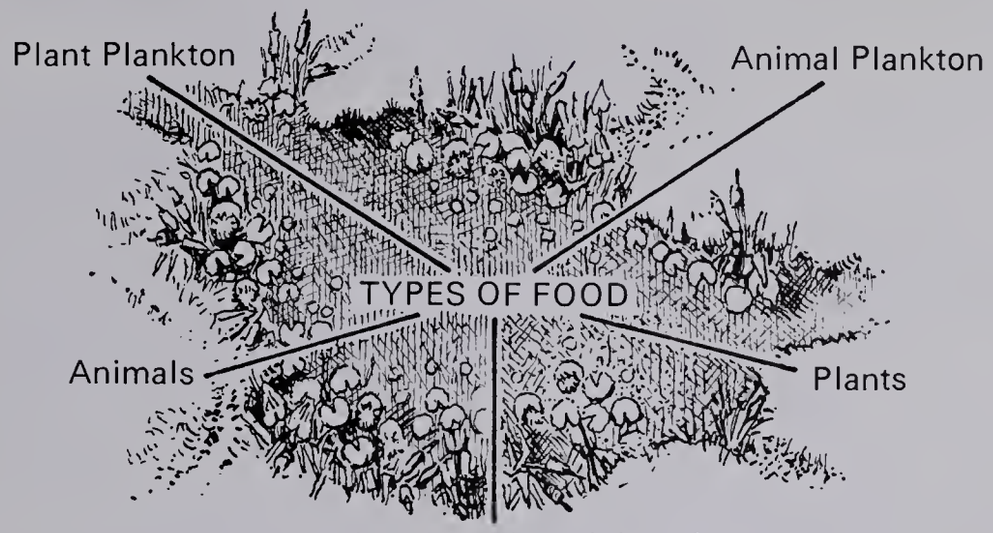
2. Watch the buds develop. When they become older they will detach from the parent hydra.

FIND THE ANSWER

The buds described above do not develop from fertilized eggs. How do hydras also reproduce by means of eggs and sperm?

FEEDING

Stream dwellers have many parts of their body adapted or suited to catching and eating certain types of food. The diagram shows the main types of food.



Activity 20
OBSERVING DIFFERENT WAYS OF FEEDING

MATERIALS

Various types of animals caught at streams and ponds

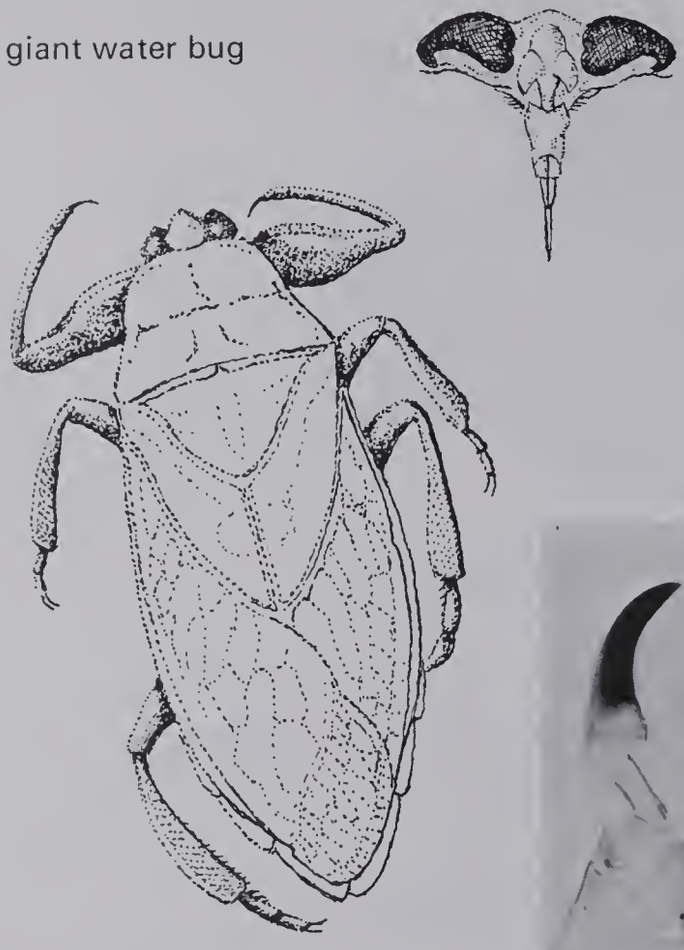
METHOD

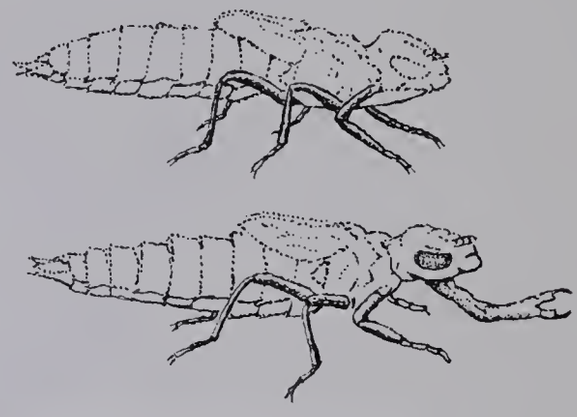
1. The feeding habits of the larger animals such as turtles, frogs, salamanders, crayfish, and large insects may be seen by the naked eye.
2. A magnifying lens or stereo microscope will make it easier to see the feeding habits of the smaller insects, worms, snails, and others.
3. In many animals the details of the mouth and leg parts used for feeding are best seen by using preserved specimens which you can handle with tweezers.

4. By watching your live animals, examining dead (preserved) ones, and reading in reference books, discover how each of the animals shown here is adapted to catch and eat the type of food that it does.

dragonfly

giant water bug





midge

A greatly enlarged view of a midge larva's mouth parts

5. Other animals you may wish to investigate are the crayfish, the hydra, the black fly larva, the snail, and the flatworm.

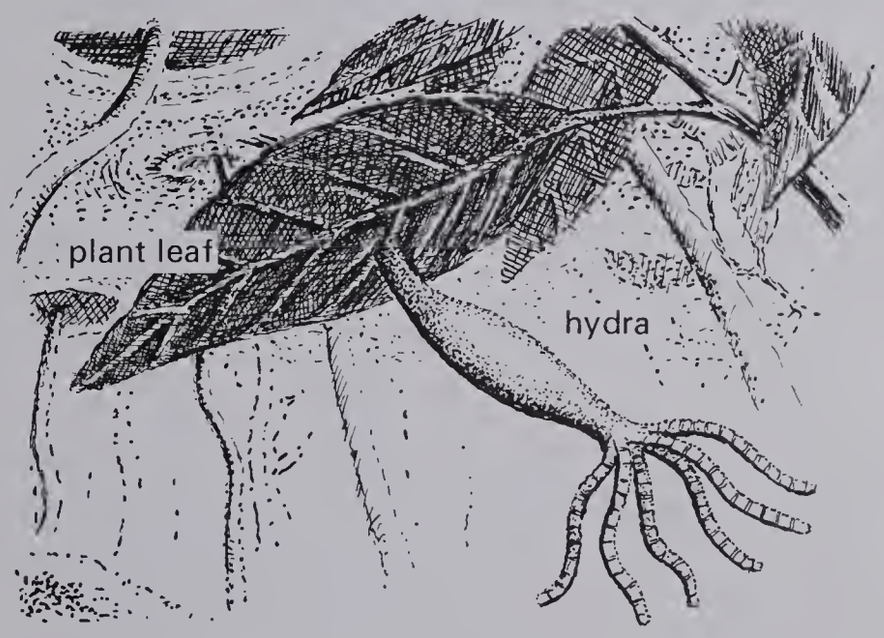
Activity 21
OBSERVING HYDRA FEEDING

MATERIALS

Hydra
Small crustaceans such as the water flea, cyclops, etc.
Culture dish with pond water and a few plant stems or leaves
Magnifying lens or stereo microscope
Tweezers

METHOD

1. You can usually find a hydra looking for food on plant stems and leaves, or on the wall of the culture dish, extended, circling slowly, waving its tentacles.



2. Watch what happens when a victim contacts a tentacle. If the hydra does not react to contact by its usual food, it is probably not hungry.

3. Notice the shape of the hydra after a meal.
4. Try feeding "hungry" hydras with very small pieces of raw meat. (Use tweezers.)

WHAT DID YOU SEE?

1. How do the hydra's tentacles catch the prey? Check at your resource centre.
2. Where does the hydra digest its food?
3. How does the hydra get rid of undigested waste?

STUDIES WITH DEAD ANIMALS

Killing and Preserving

There will be times when you will need to kill and preserve specimens from the pond or stream. A good reason for killing, preserving, and organizing a collection is to be able to examine and compare details of body structure. A knowledge of body structure will help you to identify your animals and understand how they are adapted (suited) to the area of the stream or pond in which they are found. *Do not kill your specimens simply for the sake of killing!*

The chart on the following page suggests ways of killing and preserving certain stream dwellers. It does not include vertebrate animals (snakes, turtles, frog, salamanders, fish) and aerial insects.

PRECAUTION

Some of the chemical solutions used for relaxing, killing, and preserving are poisonous if swallowed and harsh to the skin. They should be prepared either by the teacher or under the teacher's close supervision.

Do not spill or splash chemical solutions. If an accident occurs tell your teacher at once.

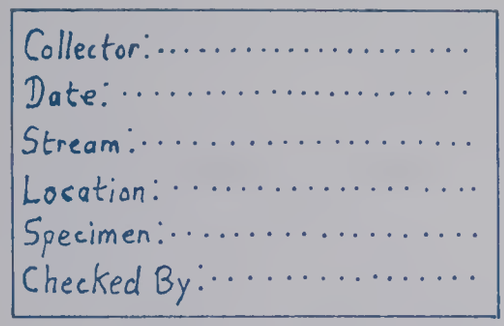
METHOD OF KILLING AND PRESERVING

small crustaceans, hydra, and insect larva (except hard-bodied ones such as bugs and beetles).	hard-bodied bugs and beetles.	worms, flatworms, and leeches.	snails, clams
1. Put animals in a solution of a small amount of water and 40% formalin. 2. Let stand for 2 to 3 hours. 3. Preserve in 70% ethyl alcohol.	1. Put in boiling water for 1 minute. 2. Let cool. 3. Preserve in 70% ethyl alcohol.	1. Relax them by placing in a flat dish with a small amount of water. Add a 5% solution of magnesium chloride until they stop moving. 2. Place flatworms in a solution of 6 parts 90% ethyl alcohol, 3 parts 40% formalin and 1 part ethyl acetate for 24 hours. 3. Preserve in 70% ethyl alcohol. 4. Place worms and leeches in a solution of 93 parts distilled water, 2 parts concentrated nitric acid and 5 parts 40% formalin. 5. Preserve in 70% ethyl alcohol.	1. Put in boiling water for 1 minute. 2. Let cool. 3. Preserve in 10% formalin (1 part formalin to 9 parts water).

Organizing a Collection

One way to keep your specimens is to place them in small glass vials filled with preservative (70% ethyl alcohol in most cases). Plug each vial with cotton, then turn it upside down in a glass jar (a baby food jar will do) and add enough preservative to cover the cotton plug. Cover the jar tightly and label it with the information on the sample label opposite.

Be sure to check your jars every three or four weeks and add preservative to replace that which has evaporated.



If you are fortunate enough to know a naturalist or professional biologist who is familiar with stream dwellers, you may have him check some of your attempts at identification. This check can be marked on your label. You may also want to colour-code your jar tops to indicate which specimens were located in ponds, which in slow-flowing streams, and which in fast-flowing streams.

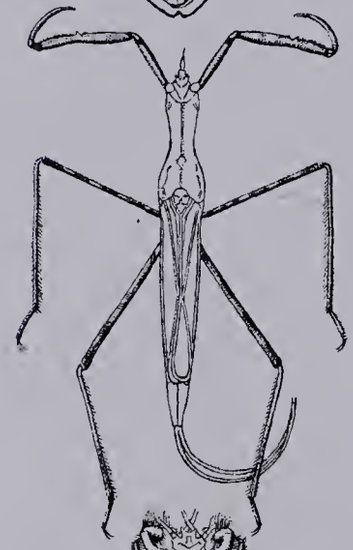
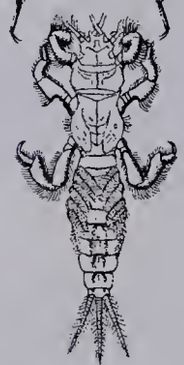
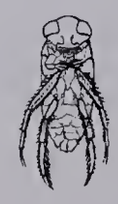
Activity 22
DISCOVERING THE USES OF INSECT LEGS

MATERIALS

Variety of aquatic insects preserved in 70% alcohol
Magnifying lens or a stereo microscope

METHOD

1. Put each specimen, in turn, in a culture dish half filled with 70% alcohol.
2. Look carefully at the size, shape, and position of the legs.
3. Try to discover at your resource centre the main use of the insect leg you are studying.
4. Decide how the size, shape, and position of the legs are suited for their use.
5. Complete this chart in your notebook.

Name of Insect	Diagram	Use of Legs	How the Legs Are Adapted for their Use
1. Lethocercus (giant water bug)			
2. Ranatra (water scorpion)			
3. Ephemera (mayfly)			
4. Gerris (water strider)			
5. Hesperocorixa (waterboat-man)			

Activity 23
DISCOVERING THE VARIETY OF GILLS

MATERIALS

Stereo microscope or a magnifying lens
Culture dish
Variety of preserved animals which use gills for obtaining oxygen

METHOD

1. Look at the position and structure of the gills of each animal. The gills of the crayfish may be seen by removing the carapace with scissors. (See page 70 for the location of this structure.) The gills of the fish may be seen by removing one gill cover with scissors.
2. Make diagrams of the gills.
3. Decide how the position and structure of the gills make them well suited for obtaining oxygen dissolved in the water.

Some animals you may wish to examine are:

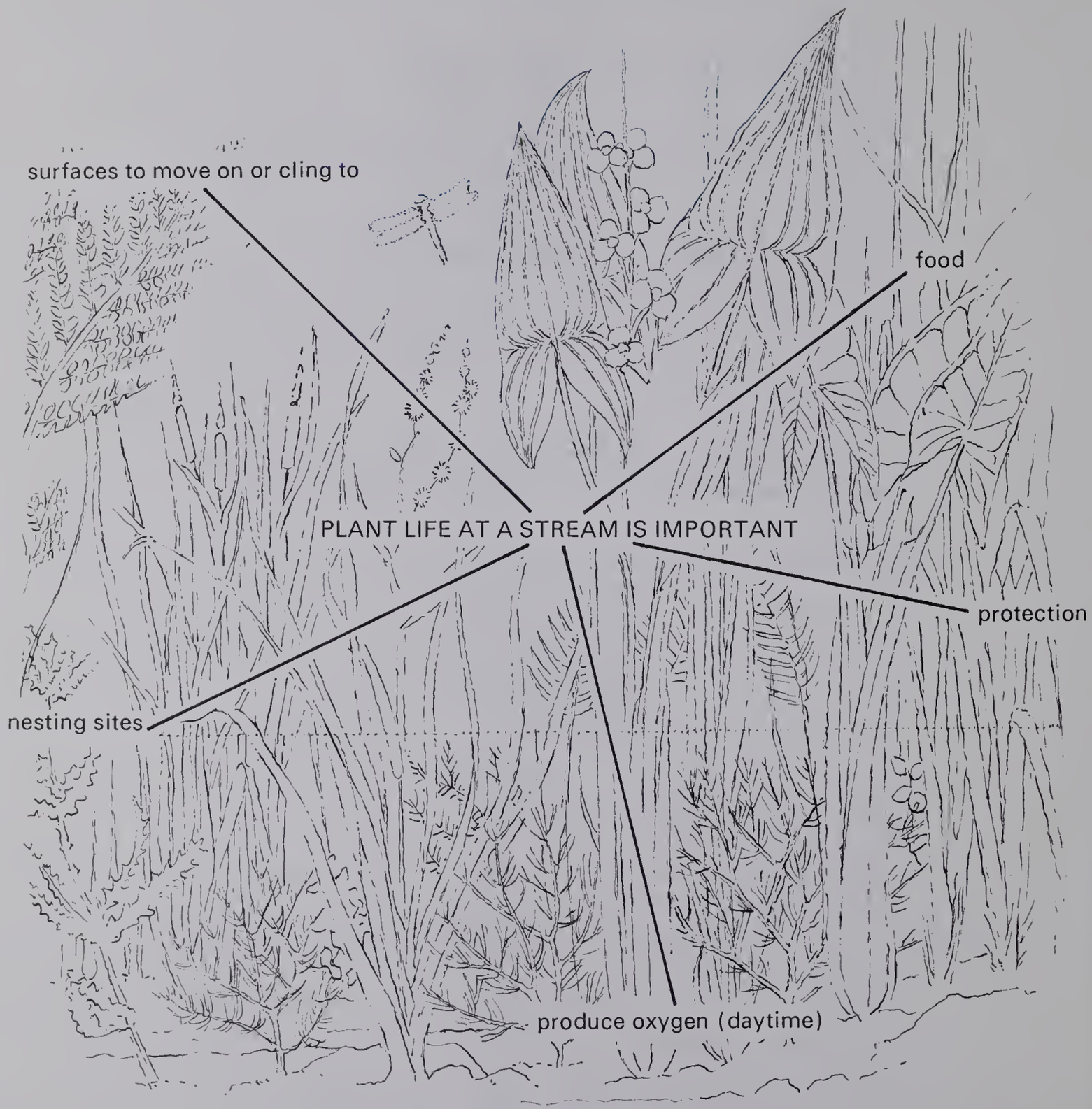
caddis fly larva
stone fly nymph
mayfly nymph
tadpole
crayfish
fish

LOOK FOR ANSWERS TO THESE

1. Why is it important that as much gill surface area as possible be exposed to the water?
2. How does the structure of some gills provide a great amount of surface area?
3. Which gills have a fine network of air tubes for conducting the oxygen throughout the body?
4. Which gills have a fine network of blood vessels (capillaries) for conducting the oxygen throughout the body?

Chapter 5

PLANTS AND STREAMS



PLANT ZONES

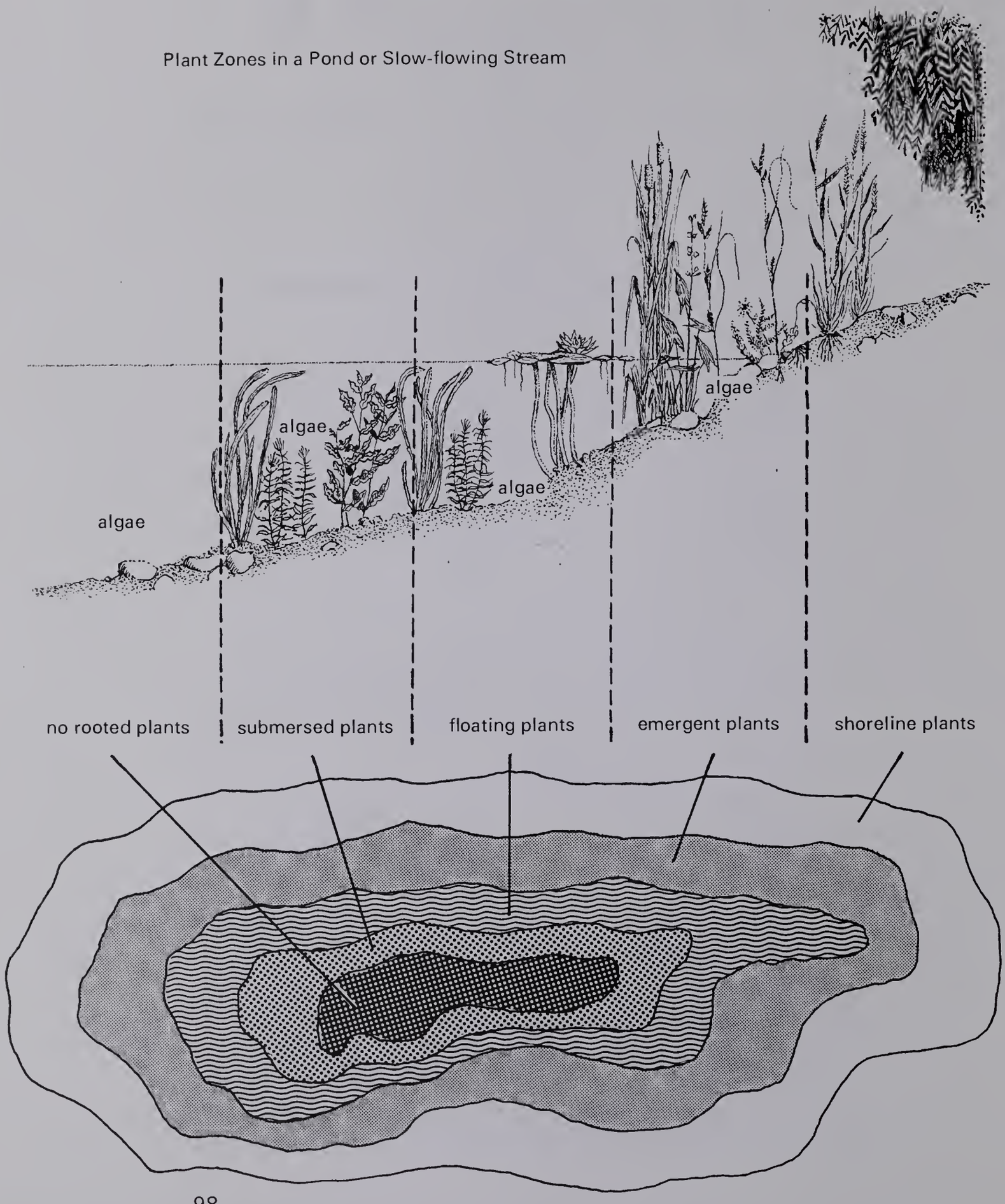
In ponds and streams where the water moves very slowly, you may find plants in four zones. Moving from the shoreline to the centre of the stream or pond these zones are:

1.	The Shoreline Plant Zone	Ground is usually wet.
2.	The Emergent Plant Zone	Plants are rooted in the mud but extend above the water surface into the air. When the water level is low these plants may become the shoreline plants.
3.	The Floating Plant Zone	Plants may or may not be rooted but part of the plant floats on the surface.
4.	The Submerged Plant Zone	Plants are rooted and do not extend above the water surface.

The line between any two zones is not sharp. For example, some submerged plants may be among floating water lilies.

You will not always find all of the zones present at one pond. In a shallow pond, water lilies and duck weed may prevent sunlight from penetrating more than a few centimetres into the water. This would hinder the growth of many submerged plants.

Plant Zones in a Pond or Slow-flowing Stream



Activity 1
RECOGNIZING ZONES OF WATER PLANTS

Find the four plant zones in this photograph. Look carefully for the submerged plants.

Which zones are present?

Pick out the four plant zones in this photograph.

Which zone can you see here?

Which zones are not evident? Why aren't they?

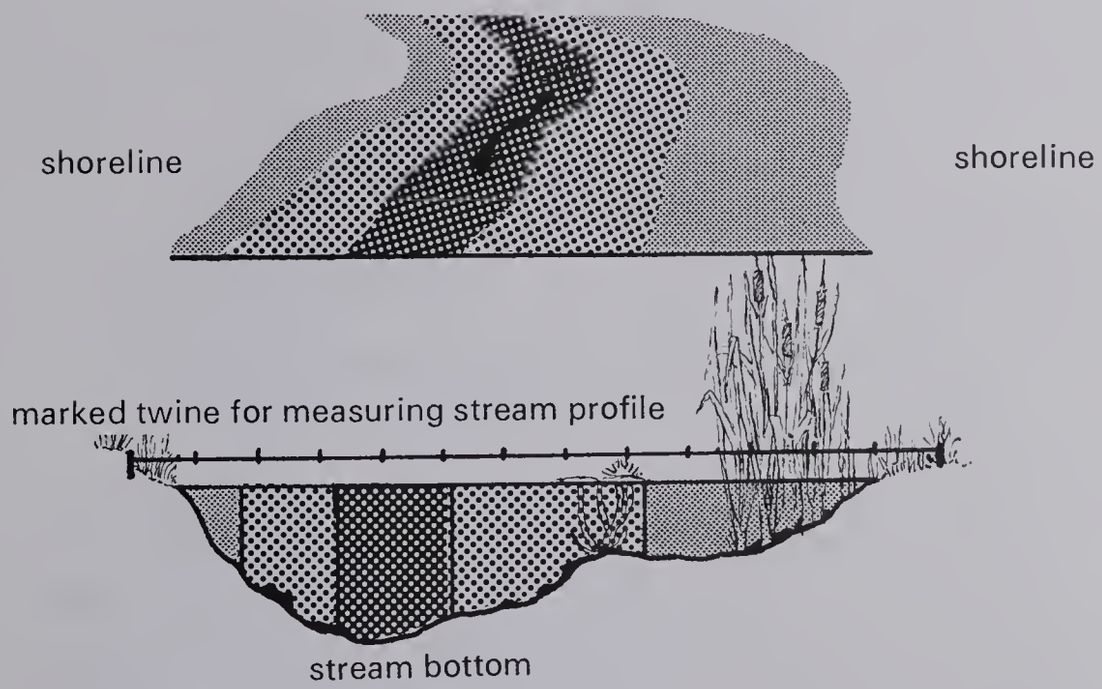
Activity 2
MAPPING PLANT ZONES

MATERIALS

Same as for Activity 5 in Chapter 3, page 32.

METHOD

1. Make a "bird's eye" diagram of the general outline of the pond or stream section you are investigating.
2. Draw lines showing the various zones of shoreline and water plants. Use a colour code to indicate the zones.
3. Plot the profile (shape) of the stream or pond bottom, as in Activity 5 of Chapter 3 (page 32). Measure the width of each plant zone along the marked twine.
4. Use your colour code to show the zones on a "side view" diagram of the stream bed.



5. Photograph the pond or stream from various angles to show plant zones. Take long-distance shots to show the zones and close-up shots to show in more detail some of the plants in each zone. The 35 mm colour slides that can be shown on a screen are very good for this purpose.

PLANT PLANKTON

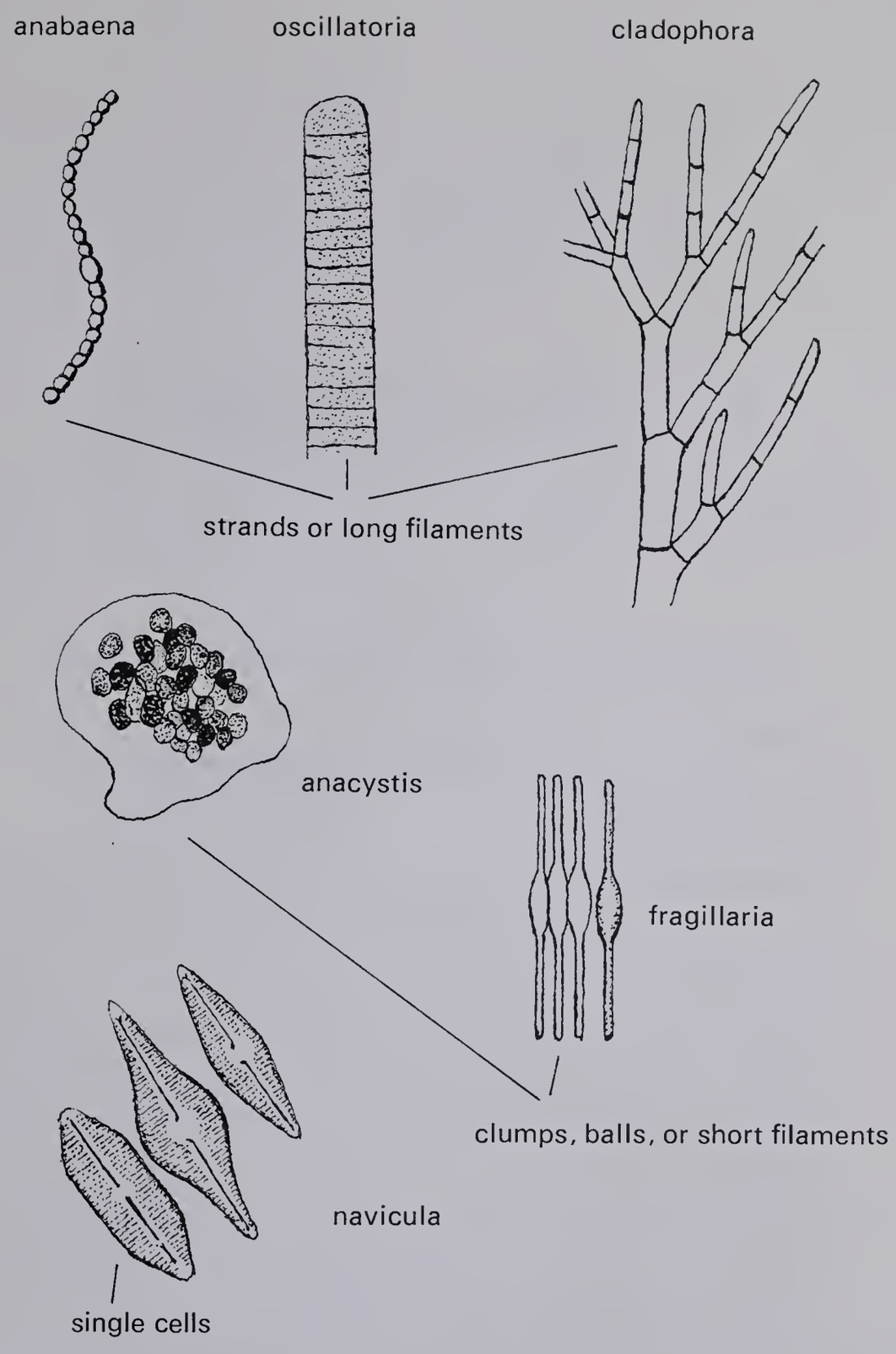
Activity 3
STUDYING ALGAE

MATERIALS

Standard microscope
Glass slides and coverslips
Medicine dropper
Plankton sample
Algae scraped from bottom rocks

METHOD

1. Algae may be found by dragging a plankton net through the water (See page 47) or by scraping the rocks on the bottom of the stream or pond.
2. Do not use much water to wash the plankton from the inverted plankton net into a glass bowl or enamel tray. If there is too much water in the bowl or tray, one drop of water, when seen under the microscope, will contain too little animal and plant plankton.
3. Make a slide similar to the one described in Activity 3 of Chapter 4.
4. If rock scrapings are used, use tweezers to place some of the material on the glass slide. Add two drops of water and apply the coverslip carefully.
5. Look for the algae under the lowest power first. Then examine it more closely under medium power. With the help of your teacher, look at small algae under the highest power. Some algae occur as single cells, some as many cells joined end-to-end to make a strand or filament, and some as a clump or ball of cells.



FIND THE ANSWERS

1. Why are algae classified as plants?
2. What are algae "blooms", "mats", and "blankets"? What causes these to form and what difficulties do they make?

3. Of what importance are algae in streams and ponds?
4. If you are interested in learning more about algae, look in your resource centre for information on the main groups of algae. These are classified according to colour—green, blue-green, yellow, and others—with thousands of kinds in each group.

SOME SPECIAL FEATURES OF AQUATIC PLANTS

The environment of an aquatic plant is quite different from that of a land plant.

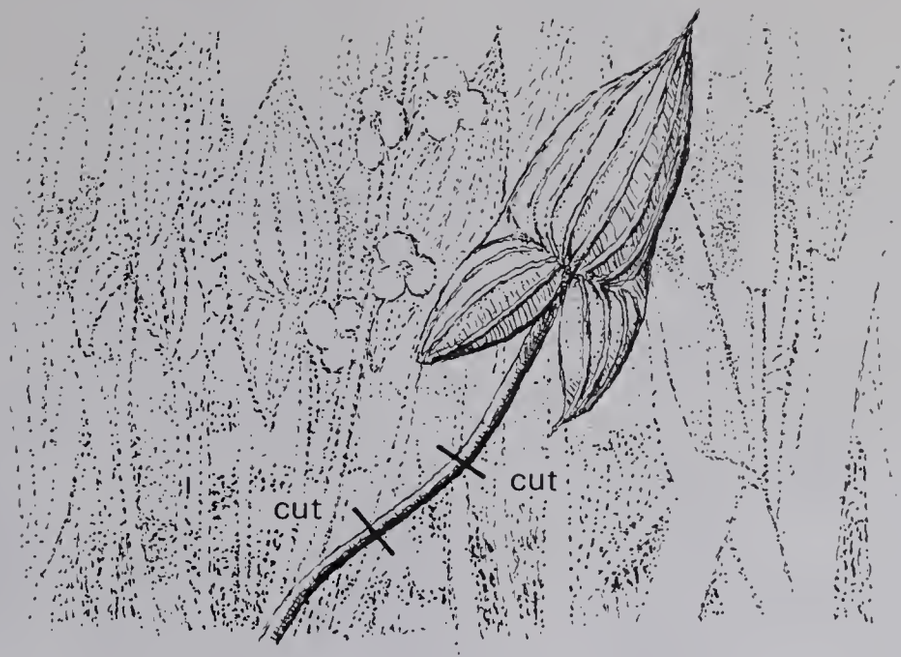
Activity 4
EXAMINING A SUBMERGED PLANT

MATERIALS

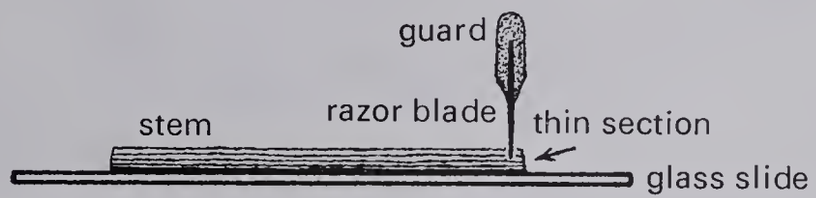
A submerged stream plant
Standard microscope
Glass slide and coverslip
Sharp razor blade
Shovel and bucket

METHOD

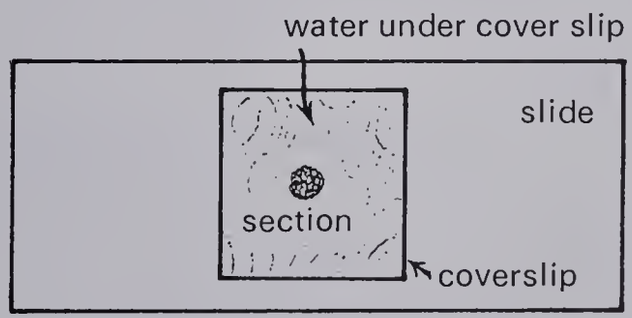
1. With a small shovel, carefully remove an underwater plant which is rooted in the mud. Elodea, Potamogeton, Myriophyllum, and Sagittaria are very common, and are good for this activity.
2. Take the plant back to your classroom in a pail of water.
3. Bend one of the stems in your fingers. In comparison with a land plant, does it bend easily? Does it break easily? What reasons might there be for any differences you notice?
4. Squeeze equal-size pieces of water plant stem and land plant stem between your fingers. Which stem seems to be stronger?
5. Using a razor blade (with a guard made by applying several layers of tape), very carefully cut a small section of stem from the water plant and lay it on a glass slide.



6. With great care, cut a very thin slice from the end of the stem. This will take much practice!

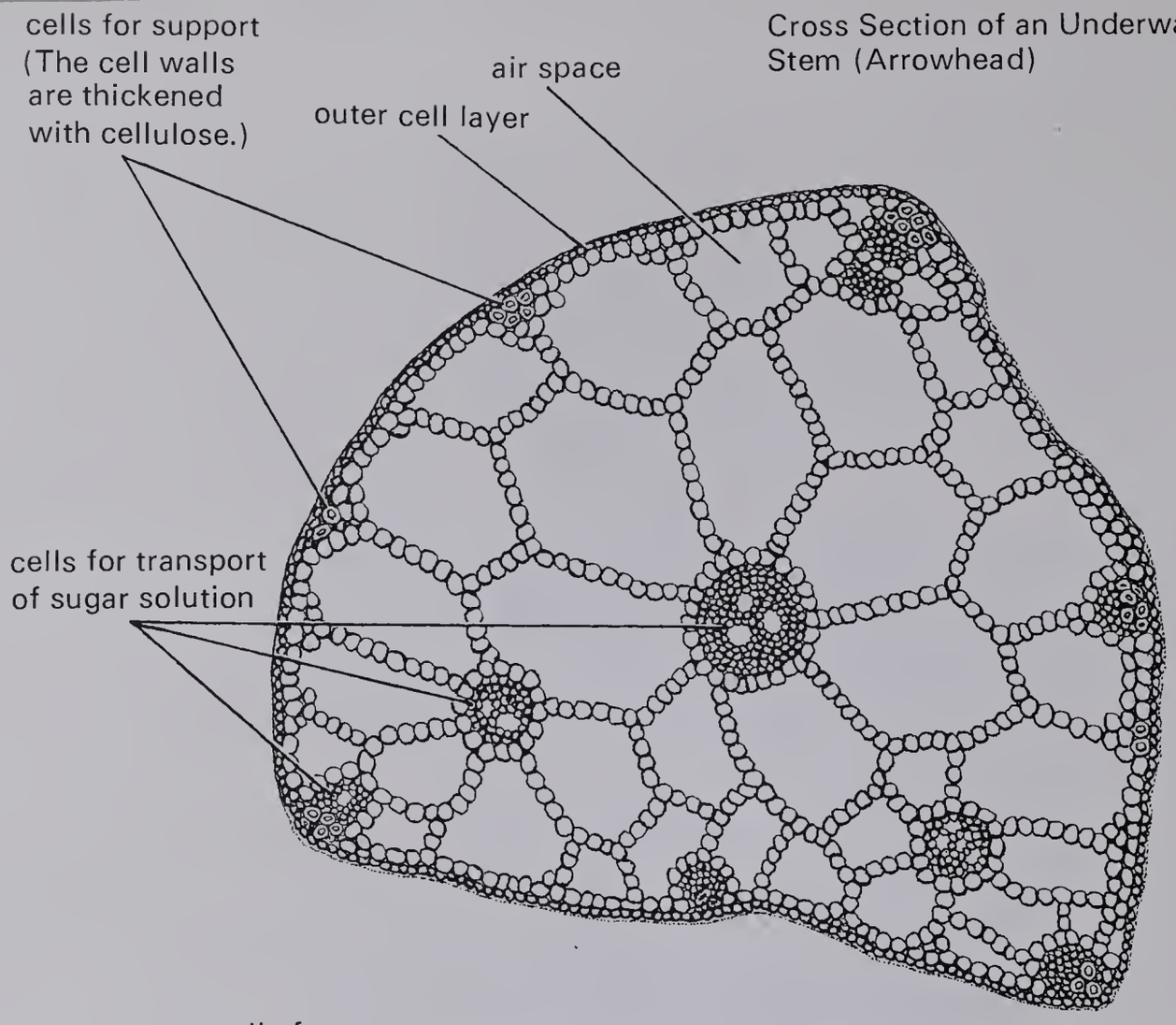


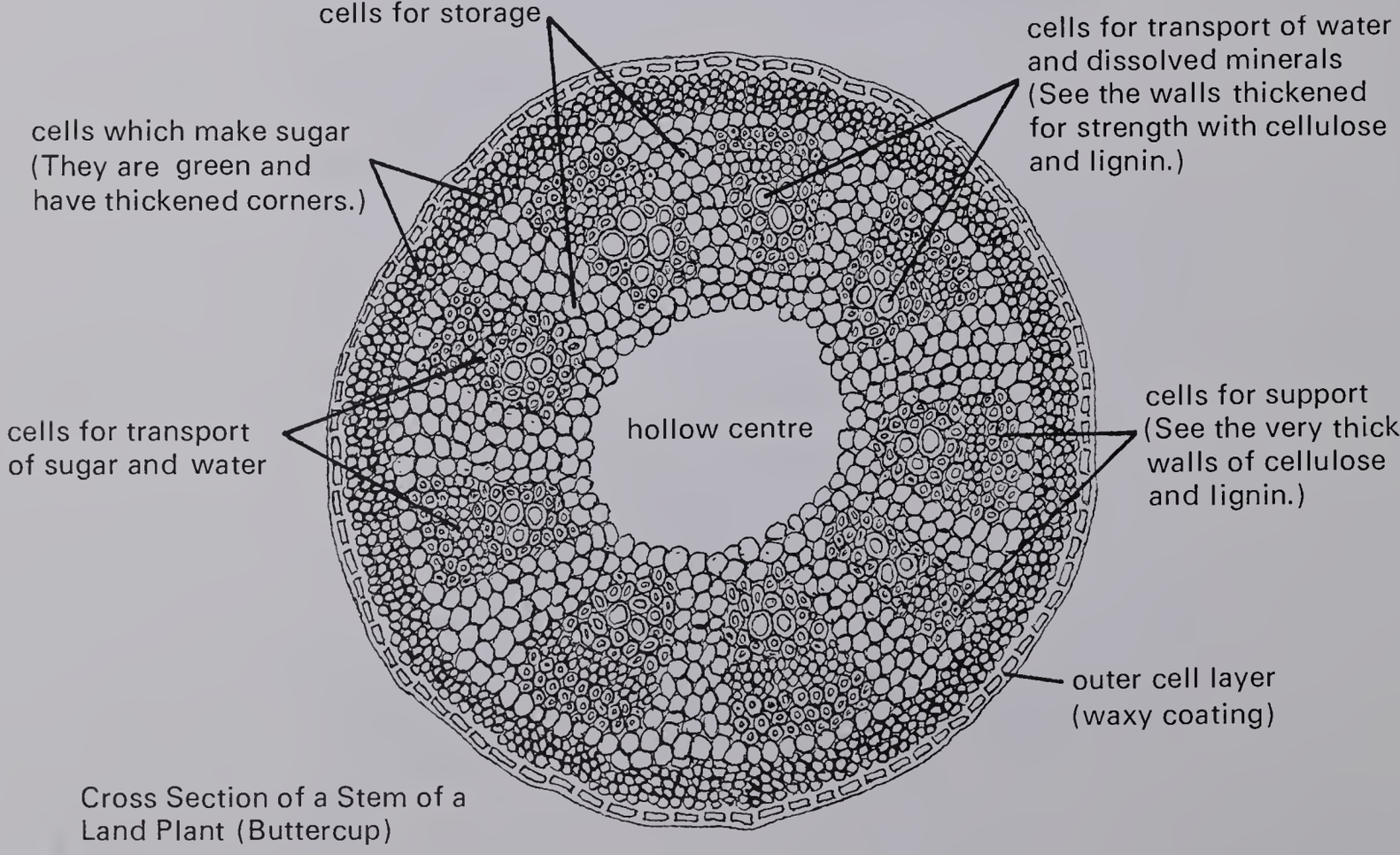
7. Gently pick up the slice with a pin and lay it down in the centre of a second glass slide. Add two drops of water and cover the thin section with a coverslip. Look at your section under the low and medium power of your standard microscope.



8. Compare your section with the diagram of a stem section of Sagittaria, the arrowhead, given here.

Cross Section of an Underwater Stem (Arrowhead)

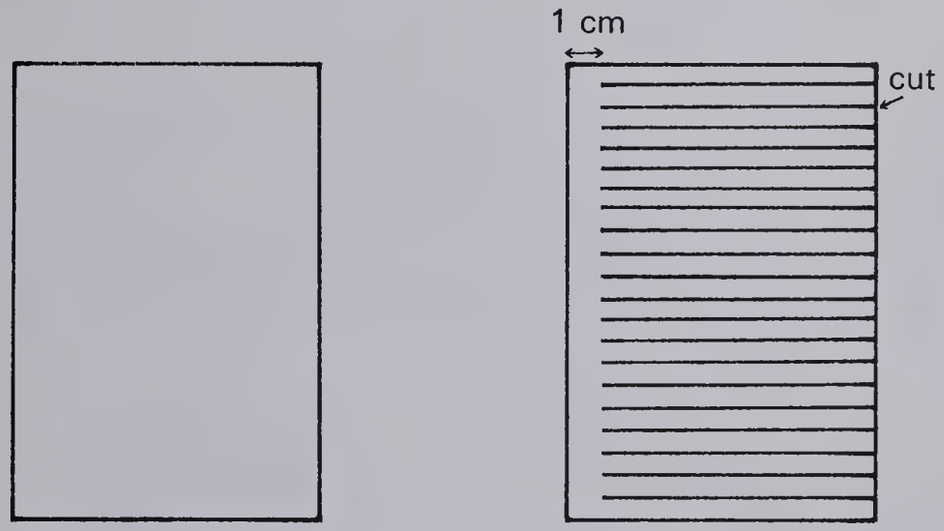

cells for support
(The cell walls are thickened with cellulose.)
air space
outer cell layer
cells for transport of sugar solution


cells for storage
cells for transport of water and dissolved minerals
(See the walls thickened for strength with cellulose and lignin.)
cells which make sugar
(They are green and have thickened corners.)
cells for transport of sugar and water
hollow centre
cells for support
(See the very thick walls of cellulose and lignin.)
outer cell layer
(waxy coating)

Cross Section of a Stem of a Land Plant (Buttercup)

What are two advantages of air spaces in underwater plant stems? Many underwater plant stems do not have cells with very thick walls for support. Nor do they have many cells for carrying water from the roots to the leaves. You can see this by comparing the diagram of the underwater stem, and perhaps your own stem section, with the diagram of a stem section of the buttercup, a land plant. Why can underwater plants get along with few or no support cells and few water transporting cells in the stem?

Describe underwater leaves. Is there any advantage in the leaves being their particular size and shape? To answer this question, try the following tests. Cut out two pieces of paper 12 cm by 8 cm In one of the pieces make about 20 cuts 1 cm from the edge.

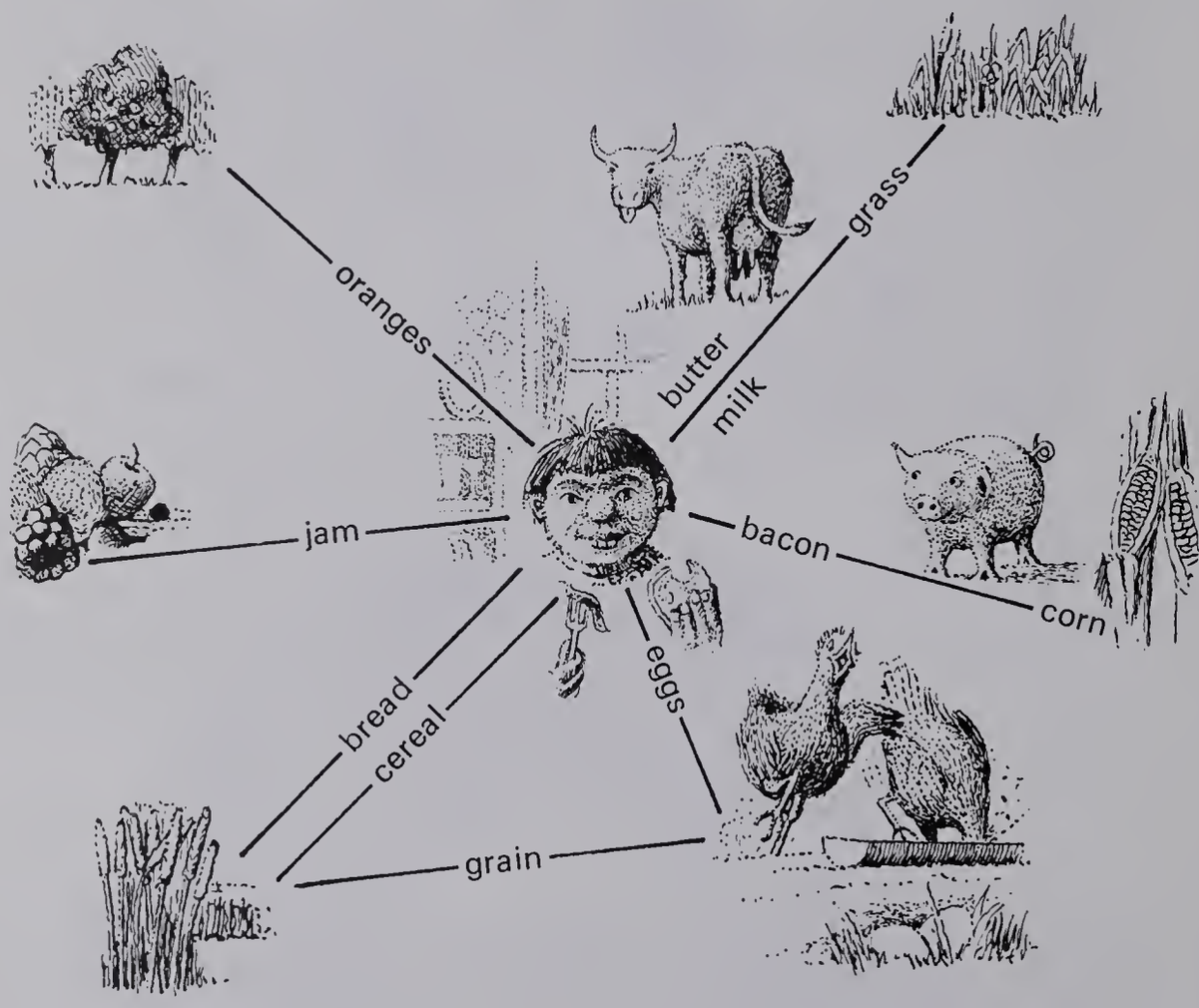


Hold, in turn, each piece of paper about 15 cm from an electric fan. Turn the paper at various angles to the fan. Which piece of paper offers the least resistance to the breeze created by the fan? If the uncut piece of paper represents one large leaf and the cut paper 20 small leaves, which would offer less resistance to the water current? If the uncut paper had been cardboard (a thicker leaf) would it have given more or less resistance than the paper (a thin leaf)? Of what advantage are small, thin leaves in flowing water?

Chapter 6

THE WEB OF LIFE

Make a list of the food you ate and drank last night at dinner. Against each item, write the name of the animal or plant from which the food came. For each animal listed, write the names of the plants on which it depends for food. The diagram shows the same type of list for breakfast foods.



You could carry this idea one step further by including the non-living factors, such as the sunlight on which the plants depend. What other physical factors might you include?

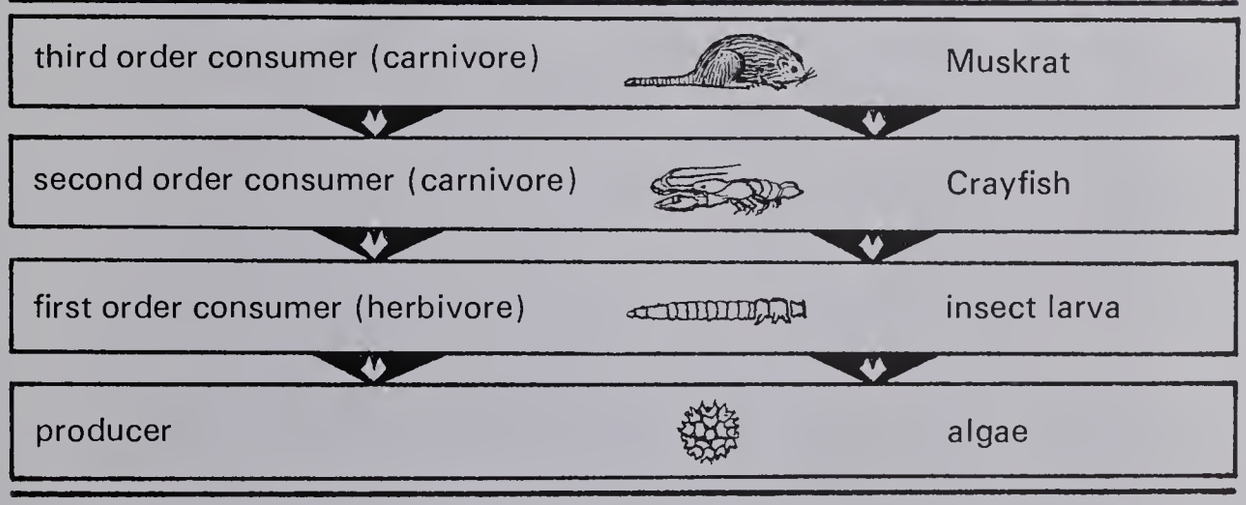
The living things, such as the green plants, that make their own food with the aid of sunlight, carbon dioxide, and water are called *producer organisms*.

Animals that eat the producers are called *first-order consumer organisms*, or *herbivores*. In the diagram, the first-order consumer, the cow, feeds on the producer organism, grass. Animals that eat the first-order consumer animals are known as *second-order consumer* animals, or *carnivores*. Those that eat carnivores are, of course, *third-order consumers* and are also carnivores.

An *omnivore* is an animal that eats both plants and animals.

What would you call the boy eating the breakfast in the diagram? What order of consumer is he when he eats bacon? When he drinks orange juice?

In a stream community, which organisms do you think will generally be the largest in size: the producers, the first-order consumers, the second-order consumers, or the third-order consumers? Why?



Which group will have the largest numbers in it? Why? Make a list of some of the producers and first-order, second-order, and third-order consumers that you have seen on one of your stream visits. Which stream dwellers are omnivores?

An animal that hunts, catches, and eats another animal is called a *predator*. The animal that is hunted, caught, and eaten is the *prey*. An animal may be a predator one minute and a prey the next! Show how this may be true, using the dragonfly nymph as an example.

The direct line leading from the producer to a first-order consumer, and from a first-order consumer to a second-order consumer, and so on, is called a *food chain*. Several food chains are shown in the diagram on page 108. In a stream community, an animal rarely depends upon only one other type of animal for its food supply, and it is rarely preyed upon by only one type of predator. If you were to diagram all the food chains of all the plants and animals in a stream community, a very complex *food web* would result.

Look up *scavenger organism* and *decomposer organism* in a biology reference book. Which stream organisms are scavengers? Which are decomposers? What important role do scavengers and decomposers play in the stream community?

Activity 1
BUILDING THE FOOD WEB IN A STREAM OR POND

MATERIALS

Cardboard for name tags
Large ball of twine
Scissors

METHOD

1. Each pupil will represent one type of plant or animal in the stream or pond community and should be identified by a name tag. Include producers, herbivores, carnivores, omnivores, scavengers, and decomposers.
2. When everyone has a name tag, sit in a circle with organisms directly linked to one another in a food chain joined by a piece of string. You may make your web more involved by including such non-living factors as sunlight, water, minerals, etc.

3. Photograph the "food web" after all the links have been made. Draw a diagram to illustrate the "food web".

NATURE CREATES PROBLEMS!

1. What can cause the problem shown in the photograph?
2. What effect can increased water speed have on the plant and animal life in the stream?
3. What type of bottom would you expect to find after these flood waters have receded? Why?
4. What happens to the finer particles of sand, silt, and clay that are carried from the bottom by a strong current?
5. What problems will the animals and plants which survive floods have to face when the water returns to its normal level? How might man suffer? How do floods sometimes help man?

1. What can cause the problem shown in the photograph?
2. What would be the effect on the animals and plants along the edge of the stream?

3. Suggest three or four ways different types of stream animals might avoid death from drying out.
4. How might the plant life survive a temporary drought?

A view of a section of the Don Valley, Toronto, Ontario, prior to the building of the Don Valley Parkway. The Don River runs through the valley.

1. Notice the exposed nature of the river bank. What has caused this condition? What may have destroyed the rooted plants that helped hold the soil?
2. What is being added to the river every time there is water runoff due to rain, melting snow, and so on?
3. How will this material affect the colour of the water and the type of bottom?
4. If sunlight cannot penetrate the river or stream water more than a few centimetres, what will be the effect on rooted water weeds and algae in the river? How will this affect the animal life in the river?
5. How can poor farming techniques contribute to a similar problem?
6. How can man correct the problem of bank or hill erosion?

1. What animal has caused the condition shown in the photograph? How?
2. What will be the effect on the water depth upstream from the dam?
3. If the water level is already high, what problem will occur?
4. What will be the effect on the water depth below the dam? What problem may occur?

How may the cattle be contributing to stream pollution?

WATER POLLUTION

Water pollution has probably killed more people than all the wars in history. Despite the advances of medical science, millions still die every year from water-borne diseases. And every year, in Canada, water pollution costs us more than all the fires, floods, accidents and other disasters across the country.

Some of our lakes and rivers are so polluted that they menace health and stifle industrial growth. Fish die in our streams while scum and algae drive us from the beaches. Tourist resorts and other businesses fail, property values fall and taxes rise with the climbing cost of water treatment.

Unless we control this growing threat it could destroy our industries, our living standards and even our civilized way of life. Not only our towns and cities would suffer, but also the countryside and wilderness where we seek refreshment.

The war on water pollution is everybody's war.

From *Water Pollution: Everybody's War*
Department of Energy, Mines
and Resources, Ottawa

Water is said to be polluted when its *usefulness is impaired*. If man cannot drink the water, bathe in it, use it for crops, fish in it or boat in it, and if the smell and taste are unpleasant, the water is said to be impaired and can be used only after expensive treatment, if at all!

We do know how pollution starts, however.

TYPE OF POLLUTION: sewage
SOURCE: man
PROBLEM: unsightly water; foul odour; oxygen in water used up by decaying sewage; disease-carrying bacteria
What will be the effect on animals and plants? What charac-

teristic would plants and animals need to have in order to live in sewage-polluted water? What are *cholera* and *typhoid*?

TYPE OF POLLUTION: food-processing wastes
SOURCE: dairies, cheese factories, meat packing plants, etc.
PROBLEM: unsightly water; foul odour; dissolved oxygen used up by decaying wastes
If you were in charge of, say, a meat packing plant located on a river, what would you do with the waste bone, skin, intestines, etc.?

TYPE OF POLLUTION: heat
SOURCE: thermal electric power plants
PROBLEM: hot water added to the river
What effect does raising the temperature of the water in a stream or river have on the oxygen concentration? (See page 41.) How would this affect the plant and animal life?

TYPE OF POLLUTION: erosion
SOURCE: improperly ploughed farmland
PROBLEM: extra amounts of sand, silt, and clay added to the stream or river
How does this extra material affect plants that need sunlight to manufacture food? How might particles of sand affect delicate animal structures such as gills? Suggest ways in which erosion of stream banks might be prevented.

TYPE OF POLLUTION: mineral salts
SOURCE: food waste; chemical fertilizers; high-phosphate detergents
PROBLEM: Extra mineral salts—in particular, phosphates and

nitrates—are added to the water, and act as fertilizer so that certain types of algae multiply far too much.
What will be the effect on the stream bottom? What will happen to the oxygen concentration as these masses of algae die and decay? The algae may also affect the taste of the water. Why is this important?

Poisonous chemicals are also added to the water when industries such as pulp mills and mines carelessly dump their waste materials. This type of pollution is difficult to detect, for the water may look, smell, and taste all right. How can we find out whether a stream is polluted by chemicals?

TYPE OF POLLUTION: insecticides and herbicides
SOURCE: spraying of crops and forests
PROBLEM: poisons brought into the stream by runoff
What is an insecticide? a herbicide? Why do they tend to accumulate in rivers and streams? What problem will develop?

Activity 2
SEEING SIGNS OF POLLUTION

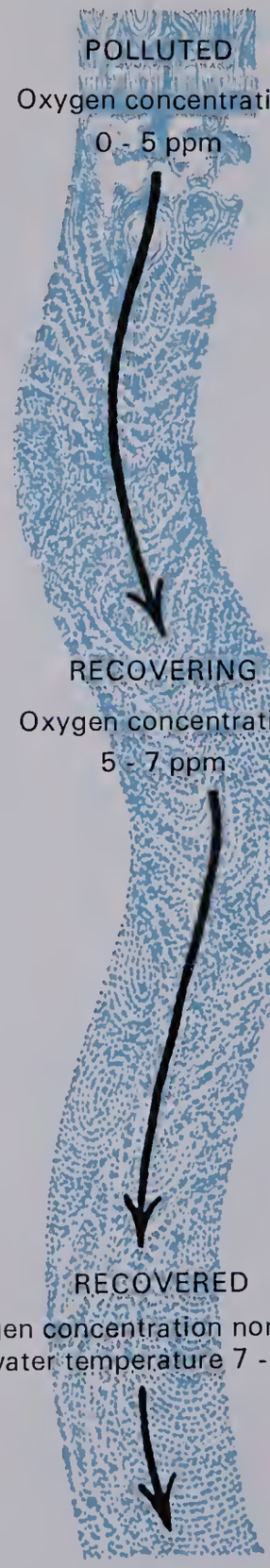
When a great amount of sewage or food waste is continuously added to a stream or river, three regions or zones may be found downstream from the source of the pollution. There is no sharp dividing line between the zones. Examine the chart to determine the characteristics of the three zones.

Notice that certain animals and plants are *pollution tolerant*. This means they can survive in sewage-polluted water. Others cannot survive and are said to be *pollution intolerant*. Organisms that are pollution tolerant either have special devices for getting their oxygen supply or do not require very much oxygen.

SOURCE OF POLLUTION

ANIMAL LIFE

PLANT LIFE



Large numbers of tolerant animals, such as mosquito, hover fly, and moth fly larvae, and segmented worms (Tubifex) but very few *kinds* of animals.

Certain types of bacteria, fungi, and algae are very common, but larger green plants very scarce. The algae Oscillatoria, Ulothrix, and Stigeoclonium are usually abundant.

More kinds of tolerant animals, including carp and catfish, more insects, in particular the midge larva, and some snails and leeches.

Fewer sewage bacteria and fungi. A greater variety of algae, and some water weeds. The algae Spirogyra and Cladophora are commonly abundant.

Good variety of animal life — fish, crayfish, plankton, snails, worms, insects.

Little or no sewage bacteria and fungi. Good variety of algae and water weeds.

If the amount of pollution added to the stream is slight, it is very difficult to discover. You may wish to make the following tests on your study stream.

SENSE INSPECTION

1. What is the colour of the water?
2. What odour can you detect?
3. Why should you not taste the water?

CHEMICAL TESTS

1. See Activity 6 of Chapter 3, which tells how to measure the oxygen concentration of the water. Take several measurements along the stream. Remember to take water temperature measurements at the same time. Why?
2. What conditions other than pollution may cause a low oxygen concentration?

ANIMAL AND PLANT LIFE

1. Take several plankton samples and try to identify the most abundant types. See Activity 3 in Chapter 4 for the method of sampling and examining plankton.
2. Take several mud samples along the stream and examine them for animal life.
3. Examine the animal life living on and under the stream rocks.
4. Try to find out from people who have fished in the stream the types and locations of their catches.
5. Find out who is responsible for testing the water in your area to determine whether it is polluted by sewage. Ask them to give you several of the special bottles used for collecting water samples. Send them samples from your stream, and ask for a report of their analysis of the water.

A type of bacteria called coliform bacteria is used as an indicator of pollution. If water is tested and found to contain coliform bacteria, further tests are carried out to discover if any of these bacteria are faecal coliform bacteria. Faecal coliform bacteria

live in the intestine of man and some other animals, and their presence in water indicates sewage-type pollution. In your province, with respect to these types of bacteria, when is water considered safe for drinking and safe for swimming?

There are many ways of presenting the results of testing your stream. This example may give you some ideas.

Test Area	Water Speed	Water Depth	Water Colour	Type of Bottom	Water Temperature	Oxygen Concentration	Animal Life	Plant Life
①	0.2 m/s	0.6 m	clear colourless	mud	21°C	8.0 ppm	A greater variety of insects were present than in area ②. There are still many midge larvae and leeches.	The faecal coliform bacteria count was lower than in test area ②. The same algae were found as in area ② Spirogyra was also quite abundant.
②	0.2 m/s	0.8 m	murky	some rocks and mud	21°C	4.0 ppm	Not many different kinds of insects were seen. Midge larvae, leeches and water-lice were abundant.	The faecal coliform bacteria count was very high. Spirogyra and Oscillatoria (algae) were abundant. Not many pond weeds were evident.
③	0.4 m/s	0.5 m	clear colourless	small rocks	21°C	9.2 ppm	A good variety of insects, nymphs and larvae were observed. Crayfish, snails and flatworms were evident. One frog was seen.	A good variety of algae were found on the rocks and in the mud. No faecal coliform bacteria were present.

Activity 3
KEEPING A POLLUTION SCRAPBOOK

MATERIALS

Scrapbook
Newspaper clippings, magazine articles, etc.

METHOD

One way to organize your scrapbook is to divide it into three sections: local pollution, provincial pollution, and federal pollution. In the federal pollution section you could include articles which tell of oil pollution from oil tankers or articles which discuss the plans of the federal government for cleaning up water pollution.

Discuss water pollution with a member of a group which is trying to do something about the water pollution in your area. When you write to invite your guest, tell him exactly what you would like to know about his group and its work. Here are some questions you might ask.

—Who is in the group?
—What is the aim of the group?
—Who finances the group?
—Who carries out the various chemical and biological tests?
—What are the achievements of the group?
—What problems does the group face?

Activity 4
FINDING OUT ABOUT POLLUTION LAWS

MATERIALS

Reference materials from local, federal, and provincial governments.

METHOD

From books and from discussions with officials, try to answer the following questions:

1. What are the laws regarding sewage pollution of lakes and rivers by cottagers, boaters, and campers?
2. Are there any restrictions on the private citizen's use of insecticides and herbicides?
3. What are the laws regarding pollution of lakes, rivers, and streams by industries?
4. What are the laws regarding sewage pollution of rivers by towns and cities?
5. Who sees that the laws are obeyed?
6. What penalties are there for breaking the laws?

Discuss with your classmates what you as individuals can do in your homes or at your cottages to prevent pollution. What can you do to stop pollution that is happening in your area?

Activity 5
VISITING A SEWAGE TREATMENT PLANT

With your teacher, arrange to visit a sewage treatment plant in your area.

Think of as many questions as you can before your visit. For example, you might want to know when the plant was built, how much waste it can treat, how much it is called upon to treat, and what is done with the waste afterwards.

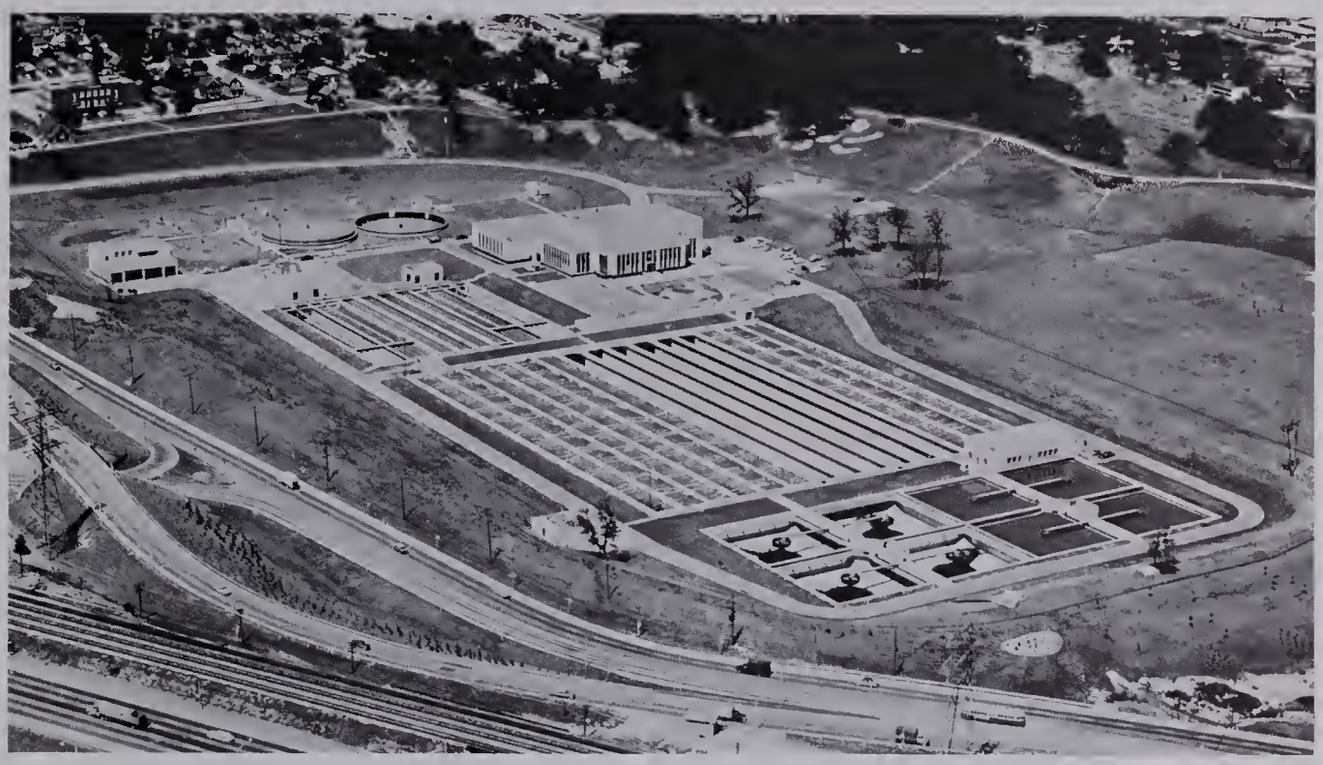
There are several types of sewage treatment. Compare the type at the plant you visit with these kinds.

1. Primary Treatment
2. Secondary Treatment
   - —activated sludge process
   - —extended aeration process
   - —trickling filter treatment
   - —waste stabilization pond method
   - —aeration lagoon
   - —oxidation ditch

3. Tertiary Treatment

Construct a large chart or bulletin board display of diagrams showing how sewage is treated at the plant you visited. Photographs could be included.

The class should be divided into several groups for the purpose of reporting on other ways of treating sewage.



Humber Sewage Treatment Plant, Toronto, Ontario

Activity 6
VISITING A WATER FILTRATION PLANT

With your teacher, arrange to visit a water filtration plant in your area.

Think of questions to ask before your visit. How is the water purified? What tests are made to make certain that the water is safe for drinking? How much water can be purified in a given time? What problems occur during a prolonged drought?

Construct a bulletin board display with diagrams and photographs to show how the water is purified by the filtration plant in your area.

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FILM LOOPS

Available from Arbor Scientific Ltd.

The Pond Environment I (Plankton)
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Available from Ealing

Pond: Animal Adaptation
Pond: Food Web
Pond: Physical Factors and Plant Adaptations
River: Plant and Animal Adaptation

FILMSTRIPS

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Animal and Plant Communities: Pond
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